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CONTENTS:

	PAGE
The Naval Boiler Question	285
On Some Methods of Determining Experimentally the Moments of Inertia of the Rotors of Dynamos and Alternators (*illustrated*)	287
Squier and Crehore on Submarine Cable Telegraphy (*illus.*)	288
Storage Batteries for Small Stations (*illustrated*)	289
Deficiencies in Car Equipments	290
The Electrical Equipment of the District and Metropolitan Railways	291
The Electrical Engineers in Paris	292
The Paris Telegraph Fêtes	293
Correspondence:—	
Current Specifications	294
Conduit *v.* Trolley (*illustrated*)	294
W. J. Davy Enclosed Arc Lamps	295
Utilising the Waste Heat of Gas Engines	296
Indispensable Accessories of Electric Traction (*continued*)	297
Cylinder Proportions for Compound Engines	299
Business Notes	299
Sunderland Electric Tramways (*illustrated*)	303
The Metropolitan Railway, Paris (*illustrated*)	305
Supply Station Accounts	313
Traffic Receipts	314
Stocks and Shares	314
Share List of Electrical Companies	315
Market Quotations	316
Automobiles as Source of Revenue for Central Stations (*concluded*)	317
Operating Economies in Central Station Practice (*illustrated*)	318
Some Developments in the Use of Price's Guard-wire in Insulation Tests (*illustrated*)	320
Fault Tests for Cable Core (*illustrated*)	321
Blast Furnace Gas	321
The Statutory Protection of Electrical Supply Companies	321
Higher Pressure Supply	322
New Patents	323
Abstracts of Published Specifications	323

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THE NAVAL BOILER QUESTION.

THE *Times* of August 10th admits into its columns an article on water-tube boilers by an engineering correspondent who considers that the water-tube boiler in some form will be the Navy boiler of the future, and at the same time he deplores the contumely heaped on the Admiralty for their Belleville policy, because he is so pleased to find the Admiralty able to make any change. The article is illustrated by cross-sections of the Yarrow boiler and the Belleville, and the action of water-tube boilers is very clearly described. The dangerous and defective action of the flatly-inclined tubes of the Belleville boiler is detailed, and the enormous length of the many-folded tubes is pointed out. The Admiralty view that the small tube types of boiler will not do for large ships, is opposed, and it is pointed out that there is a great margin of weight to provide this type of boiler with larger and thicker pipes, so as to increase their durability. Evidently the author has no faith in the Belleville boiler, but he follows the usual line that the Admiralty could not do otherwise than try the Belleville boiler, because there had been more experience gained with it than with any other type. We know of no experience of the Belleville boiler that could justify its adoption in place of the old Scotch boiler. He says that the rapid deterioration of Belleville boiler tubes . . . . proves that there are causes at work which were not foreseen, and which may turn out to be of an extremely serious nature. Now this is not quite the case. The troubles of the Belleville boiler were amply foreseen. Mr. Allan, M.P., foresaw them. All the boiler insurance companies foresaw them. We ourselves denounced the wholesale adoption of the boiler. The experiences of the Messageries Maritime, of the Brighton Railway, and of the ss. *Kherson*, came soon enough to have put a stop to the course that has boilered 62 ships with a useless and dangerous complication of fitted pipes. Much is made of the so-called long experience of the Belleville boiler. The boiler, as it exists to-day, only came out in 1880, and was first tried on the *Voltigeur*, a French ship. The earlier attempts of M. Belleville had very little in common with the later boilers, but were no more successful all the same. Long enough before 1880 the Joessel boiler was tried on the *Actif* and *Argus*. It was better in every way than the Belleville. We will not name the Oriolle boiler, because it had small tubes of 1·6 inches diameter only; but this boiler performed well and was durable. Then the D'Allest boiler dates back to 1870, and has some claims to be considered, because it employed short tubes at some inclination: but the boiler had a series of serious accidents due to exposing tubes with steam in them to the hottest gases.

As regards small tube boilers, Mr. Oram is quoted to the effect that the Yarrow boiler will give 79 I.H.P. per ton of boilers complete in a destroyer, whereas the Belleville boiler will give a maximum of 24½ I.H.P. per ton. The tubes of

the latter are from ·192 inch to ·375 inch thick, whereas the tubes of the former are only ·104 inch thick, but have lately been made ·128 and ·116 inch, according to position near the fire.

Therefore they are not so durable in face of corrosion. But it is suggested that the tubes of the Yarrow boiler, now 1¼ inches diameter, might be made 2 inches, and thickened up to a considerably greater strength without bringing up the weight of the boiler to the Belleville limit. The suggestion is made to use highly nickelised steel for boiler tubes, this material being so little corrodible as compared with ordinary steel. The nickel steel is costly, but the nation would not grudge the cost if it were assured that the use of the material was to the advantage of the Navy. No engineer could approve of such a tube as that in the Belleville boiler, but the Admiralty had evidently become so paralysed by long inactivity that when it did move its first step was a false one, and its chosen boiler was that which the *Times* contributor so plainly shows to be a mistake. The article is the more welcome in that it is from one who believes in the water-tube principle.

It is usual to divide water-tube boilers into two classes, namely, small tube and large tube, and in the course of a debate in the House, Mr. Gibson Bowles said there was no difference in principle, but merely one of tube size. The *Times* correspondent points out that the small tubes are usually "vertical," while large tubes are usually of the "horizontal" type, and the two terms thus used are taken to embrace all inclined tubes, those being called vertical which are less than 45° from the perpendicular, and horizontal those that are less than 45° from the horizontal. All tube boilers now before the public at all prominently have this difference well pronounced; but even in large tube boilers the length of each pipe need not be inordinate. The enormous length of the Belleville tubes is got by joining a number of tubes end to end by short junction boxes from which two pipes slope, the one slightly up the other down. It would appear that the idea underlying this is that one end of this long manifold tube will be at a maximum height above the other end, and circulation will be caused by the maximum difference of head. But it is overlooked that the acting head is called on to circulate water through an enormous length of pipe and round many sharp corners, and so little does circulation tend to establish itself that the lower ends of the long pipes are actually fitted with non-return valves so as to prevent circulation going the wrong way. Such a thing as a non-return valve inside a boiler is in itself out of place, as well as being a strong proof against the principle of the boiler. Is not this a powerful argument against any claim that the Belleville possesses satisfactory circulation?

Attention is drawn to the fact that in a water-tube boiler a fault in a tube, such as a split, is made worse by its internal pressure. A similar fault in a fire tube with external pressure would not develop; a split remains close, and the leakage from it is not apt to become serious. It might be added that leaky fire tubes are very readily closed by the familiar tube stopper, whereas there is no water-tube boiler in which a faulty tube can be cut out of action while the boiler is at work. Moreover, a comparatively small fault in a water tube will not merely cause such a leakage as to overpower the feed, but would often be sufficient to injure the stokers. A boiler with a mere pinhole must be laid off at once, and it must not be forgotten that the tubes of better boilers than Belleville's have been known to become perforated in 48 hours when using water from the Thames tideway.

As the *Times* correspondent states, it may be most discouraging for the professional element at the Admiralty to find that a progressive policy has been rewarded by contumely and abuse. On this score it should be noted that the Admiralty had ample warning of the incapacity of the Belleville boiler, if, indeed, any warning could possibly have been required by engineers, for whom, we suppose, is intended the phrase "professional element," for we must continue to disbelieve in the willing adoption of the Belleville type by engineers of experience, and if the Admiralty wished to be progressive, there were 50 things to be touched before a single boiler need have been remodelled.

Let the Admiralty place our Navy in the condition required by the country, which, by the way, is in no mood to bear a repetition of War Office methods.

Conduit *v.* trolley.

It would appear, from the number of persons that are being drawn into the discussion on conduit and trolley systems, that the controversy is likely to reach the dimensions of some other famous electrical questions. We do not for a moment wish it to be understood that we are opponents of the conduit system; on the contrary, we are quite prepared to admit that there may be conditions where only such a system could be permitted. Our criticisms have been directed rather against the methods and futile arguments of its advocates than against the system itself. If the members of the London County Council were genuinely of opinion that the conduit system was the only one practicable for London, and had arrived at such views after careful investigation of the operation of all electric traction systems, one might have very little reason to object. But the more we study the attitude of the Council the more we are convinced that its information is one-sided, and its opinions in consequence biassed. Nor has the newspaper controversy done much to clear up matters; it has rather helped to disseminate a good many false ideas on the subject of traction. As an instance of how people are misled, we were actually informed, by an engineer too, that the overhead wires were being abandoned in America in favour of the surface contact and the underground conduit system. We have attempted to deal with some portion of the newspaper controversy, but as the subject of the conduit is being taken up by various newspapers, we fear that it will be impossible to explode all the fallacies that are being so widely published. The *Westminster Gazette* and Mr. Warren, of the Westinghouse Company, have been making a serious attempt to put everybody right on the subject of the conduit; in their joint opinion the London County Council is justified in adopting the conduit, and though we can quite understand Mr. Warren approving the action of the London County Council, we should have liked our contemporary to have advanced some reasons for the attitude which it has taken up. Mr. Warren points out, in the *Westminster Gazette*, that there is no impossibility from a mechanical or an electrical point of view in laying down a conduit, and with this statement most people would be inclined to agree; but the main question which concerns Londoners at the present moment is whether the well-known and recognised advantages of the conduit are worth the exceptionally heavy cost which must be incurred. It is perhaps undesirable to have any form of overhead structure in London streets, and probably for such reasons the conduit would be the only system for streets similar to the Strand, Piccadilly, Victoria Street, and many of the main arteries of the City. In such places the heavy expenditure on the conduit might be fully justified, but we decline to admit that the conduit is necessary in most of the thoroughfares south of the Thames bridges. We have no sympathy with the biassed views of the thick and thin opponents of the conduit; their views are no more to be tolerated than those upon which we made severe strictures last week. We are not anxious that the conduit should be neglected, but we certainly object to the overhead trolley being misrepresented, and our remarks were mainly directed to this end. There is one phase of the London tramway question in which we heartily sympathise with the London County Council, and that is in the attempts to provide a unified system of traction. The acute nature of the transit problem is in a large measure due to the want of uniformity in the carrying arrangements of London; and any scheme which makes for that end is deserving of support. The small local authorities of London, however, can absolutely veto any complete system of tramways if they are so disposed, and from the public point of view as well as that of the electrical industry, it is regrettable that the County Council is meeting with so much opposition.

ON SOME METHODS OF DETERMINING EXPERIMENTALLY THE MOMENTS OF INERTIA OF THE ROTORS OF DYNAMOS AND ALTERNATORS.

By ALFRED HAY, B.Sc., M.I.E.E.

Of what interest or importance to an electrical engineer is a knowledge of the moment of inertia of a dynamo armature? Had the question been asked some ten years ago, most practical men would probably have answered "None," without any hesitation. But we live in an age when a matter which one day is regarded as of interest to pure science only may the next day suddenly become one of great practical concern. And so it has happened with the particular problem of the present paper. Until recently, probably no electrical engineer ever suspected that the moment of inertia of the rotor of a dynamo or alternator was a quantity which was destined to be of prime importance in connection with certain problems. There are two such problems in existence at the present moment. One of these is the analysis of the various losses which take place in a generator; and the other is a problem connected with the parallel running of alternators.

A few words regarding the first problem may not be out of place. Let I be the moment of inertia, expressed in C.G.S. units, of the rotor of a dynamo or alternator. Let the angular velocity at a given instant be ω, and let us suppose that after the machine has been run up to a certain speed on open circuit, the supply of power to the armature is suddenly cut off, and the machine allowed to come to rest. The retarding torque, T, in C.G.S. units, acting on the rotor is given by

$$T = - I \frac{d\omega}{dt},$$

and the corresponding power is

$$T\omega = - I \omega \frac{d\omega}{dt}, \text{ in ergs per second,}$$

$$\text{or } - 10^{-7} I \omega \frac{d\omega}{dt} \text{ in watts.}$$

Hence if I, ω and $\frac{d\omega}{dt}$ are known, we have a means of calculating the power which produces retardation. Now this power must be the exact equivalent of the rate at which energy is being dissipated by bearing friction, brush friction, air friction, hysteresis, and eddy currents at the speed ω.

Let us suppose that by suitable means ω has been obtained as a function of the time, so that when plotted it enables us also to find $\frac{d\omega}{dt}$, and let us further suppose that the experiment is performed (*a*) when the machine is not excited, and the brushes or other rubbing contacts have been removed; (*b*) without excitation, but with rubbing contacts in place; (*c*) without rubbing contacts, but with full excitation. The power corresponding to (*a*) measures the loss by bearing and air friction; that corresponding to (*b*) the loss due to bearing, brush and air friction; and that corresponding to (*c*) the loss due to bearing and air friction, hysteresis and eddy currents.

The loss due to heating of the armature and field coils is easily calculated. We thus have a method of not only determining the total waste power, and from it the efficiency of the machine, but also of analysing the various losses. Further, the method may be employed for studying how the various losses vary with the speed.

So far as the author is aware, the method sketched out above was first suggested in 1893 by Mr. J. R. Ashworth in in a letter to the *Electrician*,* although it does not seem to have been tested by him practically. The editorial comment on the letter was somewhat unfavourable, and there the matter was apparently allowed to rest. It was not until 1896 that M. Routin† published a paper giving not only an account of the method, which appears to have been devised by him independently, but the results of actual tests. Quite recently, C. Liebenow‡ has given an account of the same method, evidently quite unaware of the fact that others had also suggested and used it.

The waste power as determined by this method is somewhat less than the actual loss taking place at full load. On account of the field distortion produced by armature reaction, the hysteresis and eddy current losses at full load will generally be greater than those which take place in the undisturbed field. This increase of waste power at full load has formed the subject of several papers.*

Turning now to the second problem in which the moment of inertia of the generator plays an important part, we may point out, that it is one which has claimed a great deal of attention during the last few months. The problem is that of the "hunting" or "see-sawing," or "phase-swinging," as it is variously termed, of parallel-connected alternators. The literature relating to this particular subject is surprisingly extensive, and, what is still more remarkable, dates pretty far back. The phenomenon seems to have been first investigated by P. Boucherot,† who in 1892, in a series of articles dealing with the parallel running of alternators, gave a formula for the period of the oscillatory movement, which is superposed on the motion of uniform rotation of an alternator. In the course of the same year, A. Blondel‡ published a series of articles dealing, among other things, with this particular problem. More recently, it has formed the subject of a large number of contributions by various writers, including G. Kapp,§ J. Guillaume,‖ L. Wilson,¶ and G. Benischke.** A very thorough discussion of the subject will be found in a recently published elaborate paper by H. Görges.††

It is not the intention to deal with this subject here, beyond merely pointing out that the presence or absence of the troublesome phenomenon of "hunting" is largely dependent on the value of the moment of inertia of the rotating part of the generator. If, in fact, this moment of inertia, as well as certain other quantities are known, it becomes possible to estimate roughly whether under given conditions the alternator is likely to "hunt" or not.

Enough has been said to show that the moment of inertia of the rotor is far from being a quantity which to an engineer possesses abstract interest only. We shall now consider some methods by means of which this quantity may be determined experimentally.

Method 1.—The usual method of torsional vibrations employed in a physical laboratory is probably one of the most accurate methods at our disposal, and may be conveniently used so long as the rotor is not of unwieldy size. The rotor is suspended by means of a steel wire-rope with its axis vertical, and, having been displaced by a rotation round its axis through a convenient angle from its position of equilibrium, is allowed to oscillate. The time, T_1, of a complete oscillation is determined. The moment of inertia of the rotor is next increased by suitably loading it with weights distributed symmetrically round the axis, the weights being of such a shape and so placed that the total additional moment of inertia, I_w, due to them may be calculated. The rotor is once more set swinging, and the new periodic time, T_2, is as before determined. If I stand for the moment of inertia of the rotor in C.G.S. units, then, I_w being similarly expressed in C.G.S. units, we have, as is well known,

$$I = I_w \frac{T_1^2}{T_2^2 - T_1^2} \qquad (1)$$

This method was applied to determine the moments of inertia of a 5-KW. dynamo armature, and the rotor of a 3-KW. Pyke & Harris inductor alternator.

The dynamo armature was of the Gramme type, and was provided with a pulley of large diameter. A gunmetal collar was fitted to the end of the spindle for the attachment of the suspending rope, which consisted of four strands of steel wire, and the armature with its pulley was suspended from a strong wooden trestle about 13 feet high. The

* The *Electrician*, Vol. xxx., p. 459.
† *Eclairage Electrique*, October 24th, 1896.
‡ *Elektrotechnische Zeitschrift*, 20, p. 274.

* O. T. Blathy, The *Electrician*, Vol. xxxvii, pp. 375 and 474, 1896. W. M. Mordey, p. 447. H. J. Ryan, *Electrical World*, Vol. xxviii., p. 272, 1896.
† *La Lumière Electrique*, Vol. xlv., p. 201 et seq.
‡ " " Vols. xlv. and xlvi.
§ *Elektrotechnische Zeitschrift*, Vol. xx., p. 134, 1899.
‖ *Eclairage Electrique*, xx., p. 281, 1899.
¶ *Journal I.E.E.*, xxviii., p. 395, 1899.
** *Elektrotechnische Zeitschrift*, xx., p. 870, 1899.
†† " " xxi., p. 188, 1900.

arrangement is shown in fig. 1, where it is drawn roughly to scale. Oscillations were next started by turning the armature through a small angle, and then letting it go (care being taken not to set up any pendular motion). The time of 20 complete oscillations was found to be 427 seconds, giving for T_1 the value 21·35 seconds. The armature was then loaded with a number of slotted circular weights (as shown by the dotted circles in fig. 1) distributed as symmetrically as possible round the rim of the pulley. The moment of inertia of each weight about an axis passing through its centre of inertia in a direction parallel to the suspension could be easily calculated from the dimensions of the weight, and from this the moment of inertia about the axis of vibration could be easily deduced.

Fig. 1.

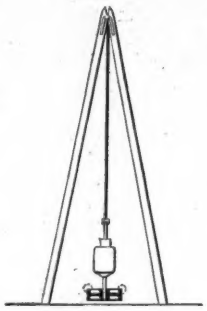


Fig. 2.

The total additional weight distributed over the pulley rim amounted to 22 lbs., and the corresponding additional moment of inertia, I_w, was found by calculation to be $5{\cdot}15 \times 10^6$ C.G.S. units. The new periodic time of vibration, T_2, amounted to 26·1 sec. Hence by formula (1) we get

$$I = \frac{5{\cdot}15 \times 10^6 \times 21{\cdot}35^2}{26{\cdot}1^2 - 21{\cdot}35^2} = 10{\cdot}47 \times 10^6 \text{ C.G.S. units.}$$

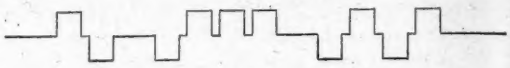
The rotor of the Pyke & Harris inductor alternator was a much lighter structure, and the weights could not be conveniently attached to it as in the case just considered, on account of the much smaller size of pulley. Instead of this, two small holes were drilled and tapped in the thick rim of the pulley in a direction parallel to the spindle of the rotor, and a horizontal iron lever, with two pins screwed in at its ends, was fixed to the pulley rim; this lever is shown in fig. 2. The slotted circular weights could be placed round the pins at the ends of the lever. The moment of inertia of the rotor was found to amount to $7{\cdot}33 \times 10^6$ C.G.S. units.

(To be continued.)

SQUIER AND CREHORE ON SUBMARINE CABLE TELEGRAPHY.*

We have received from the authors, Messrs. Crehore and Squier, a copy of a paper on cable telegraphy read before the American Institute of Electrical Engineers, in which an account is given of a series of experiments conducted during a space of nearly two years on the cables of the Commercial Cable Company of New York. The experiments were designed to ascertain the effect of sending signals by connecting the cable to an alternating current dynamo during one half a single alternation instead of to a battery. Fig. 1 shows the course of the potential of the cable at the transmitting point when the letters A B C are sent by connecting the cable during $\frac{3}{4}$ of each element to a battery, and to earth during the remaining $\frac{1}{4}$, with, of course, longer periods of earth connection to separate the letters. Fig. 2 shows the course when instead of using a battery the cable is connected to a source of alternating E.M.F. during half of an alternation period, chosen so that during the whole of that half period the E.M.F. is in the same direction.

For sending the signals of fig. 1 with a battery a Cuttriss transmitter was employed, in which the contacts are made by springs touching a contact cylinder through holes perforated in a paper tape. For sending signals with an alternating E.M.F. as in fig. 2, a special transmitter was used, in which the wheel that fed the paper was geared to



Letters A, B and C. Battery form of E.M.F. wave.

Fig. 1.

the shaft of an alternating dynamo, and the holes through which the spring contacts were made were perforated in such positions that each contact just lasted through one half of an alternation.

The construction is clearly given in the paper; there is no difficulty in imagining ways of carrying out such an operation, and it is outside our present purpose to discuss the details of the mechanism. It is evident that a good

Letters A, B and C. Sine wave E.M.F.

Fig. 2.

deal of care was taken to secure a true sine curve from the dynamo, a result which was obtained from a drum-wound armature, after a shuttle-wound armature had previously been tried which gave a very irregular peaked curve.

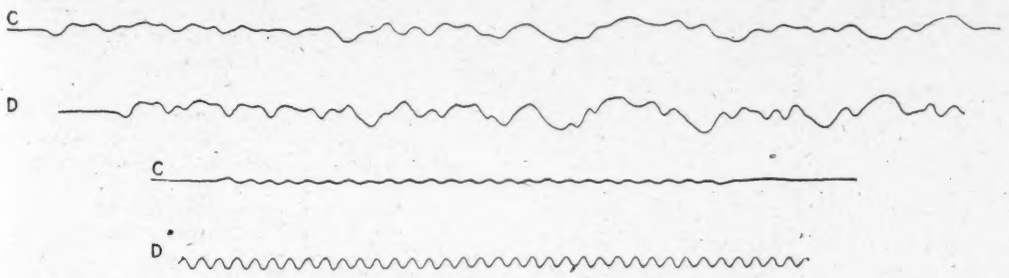
The authors proceeded to examine the law of transmission of such alternating currents through cables. In all cases the observations were made with the instrument at the receiving end arranged on a bridge as for duplex. At the sending end the transmitter was connected in some experiments directly to the cable, in others to the apex of the duplex bridge. The amplitudes and phases of the E.M.F. forces and of the currents passed into the cable were measured with a dynamometer and an electrostatic voltmeter, and the close correspondence of the measurements, and of the impedances calculated from them, with the values calculated from the known constants of the cable and instruments, show this part of the work to have been done with great care and thoroughness. The instrument used at the receiving end was an ordinary siphon recorder, and the extent of the excursions of the syphon trace was the measure of the value for telegraphic purposes of the received currents, and was observed for many different electromotive forces and frequencies of transmission. In consequence of this proceeding, the characteristics of the receiving instrument, viz., the natural period of the coil, its damping, &c., which are not given in the paper, are concerned in the result, as well as the amplitude and frequency of the received current; and although the results so obtained give information which is immediately applicable to practice, yet they are not easily compared with theory.

A number of traces are given in a diagram of the effect of regular alternations produced in various ways: by the drum armature giving a true sine curve; by the shuttle armature giving a peaked curve; and by the Cuttriss transmitter giving a flat-topped curve; and in every case the trace is a smooth sinusoidal curve. The authors point out that if the periodic curve of the impressed force be analysed into a series of harmonic components, the amplitudes of the higher harmonics are reduced in passing along the cable so much more than those of the lower harmonics that in a long cable only the fundamental practically survives, and the syphon trace is simplified to this. This is, of course, broadly the case, though a reader who cares to go into this question further may refer to an article published in these columns in August, 1897, in which the transmission of several harmonics in determined proportions was discussed for a typical case. It would appear that in these experi-

* "A Practical Transmitter using the Sine Wave for Cable Telegraphy and Measurements with Alternating Currents upon an Atlantic Cable." Read before the American Institute of Electrical Engineers, Philadelphia, May 18th, 1900.

ments smooth undulatory curves would have been produced in any case by the action of the recorder, since a curve of this kind was obtained from a shuttle-wound armature on a plain resistance when the oscillograph gave a curve of an exceedingly irregular and peaky form, so that the smoothness of the syphon trace is not necessarily due to the absence of higher harmonics from the received current.

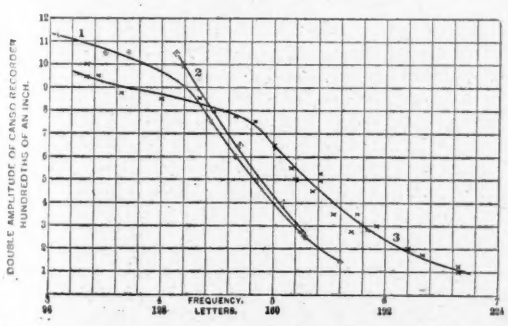
The authors give the particulars of the amplitudes of the syphon trace using many different periodicities and electromotive forces at the transmitting end, and these results are particularly valuable and interesting. The experiments were conducted on the Coney Island cable, between New York and Canso, which has a resistance of 13,700 ohms, and an



c, Cuttriss transmitter, 180 letters per minute. $n = 5{\cdot}61$ max. 36 volts on cable.
d, Sine wave " 182 " " $n = 5{\cdot}66$ " 33 " "

FIG. 3

electrostatic capacity of 231·4 mfds. at 75° F. It was found that the amplitude of the siphon trace for any given frequency was proportional to the electromotive force used for transmission, so that for a given frequency the deflection of the siphon was proportional to the received current. The variations of the amplitude of the siphon movements for different frequencies, and with different transmitting instruments are given in a diagram, reproduced in fig. 4, which shows a striking difference between the values for a true sine wave transmitter, and those for a flat topped or peaked wave. The former gives much larger amplitudes at the higher frequencies tried than the latter. As a practical example of the advantage gained by the use of the sine wave transmitter a specimen is given of actual slip, which is reproduced in fig. 3.



Relation between frequency and the double amplitude of the receiving recorder :—1. The Cuttriss transmitter ; battery 36 volts. 2. The pointed wave alternator ; 30 virtual volts upon apex. 3. The sine wave alternator ; 31·1 virtual volts on apex.

FIG. 4.

In order to compare the results of two systems it is not sufficient to compare them on the basis of using equal E.M.Fs. for transmission. They must be compared on the basis of putting equal strains on the dielectric of the cable. The authors of the paper clearly recognised this, and have given a great deal of attention to calculating the maximum electrostatic pressure in the cable itself when known alternating E.M.Fs. are applied to the apex of the duplex bridge, and they think an E.M.F. of transmission of given amplitude which follows a pure sine wave not only has an advantage over a flat-topped wave, such as is sent by a battery transmitter, in producing larger movements of the siphon, but that it actually throws less strain on the dielectric. In this argument we are not able to follow the authors, nor in that which explains why there is a gain in speed in using the sine wave instead of the battery of the same maximum voltage. It is clear that the amplitude of the first component of a flat-topped wave is greater than the amplitude of the wave itself, and that by an amount which is greater than in any other form of wave of the same maximum amplitude ; so that according to their theory, the battery transmitter should be better than any other.

The kernel of the paper lies in the results given in figs. 3 and 4, and it does not seem to us that the long theoretical discussions throw any light on the cause of the difference between the actions of the two transmitters. An unsatisfactory part of the paper is that no information is given as to the values of the received currents (what is given everywhere is the siphon trace) so that we are left quite in the dark as to whether this peculiar effect is due to the instrumental conditions of the syphon coil, or whether it indicates a failure of the accepted theory of cable signalling. The form of curve 3 in fig. 4 is very different from the curve of the received currents calculated from the theory, and seems to show that the conditions of the receiving instrument are largely responsible for its shape. On the other hand, the difference between the traces of fig. 3 can hardly be due to the instrument. On the whole the evidence seems to be in favour of a failure of the theory, and of great importance. If the transmission of electrical interferences along cables does not follow the accepted law, according to which the transmission of any harmonic is unaffected by the existence of others, there may be possibilities of improvement in cable telegraphy in an unsuspected direction.

STORAGE BATTERIES FOR SMALL STATIONS.

A PAPER was read last June before the North-Western Electrical Association in Wisconsin, U.S.A., by Mr. Louis A. Ferguson, on the subject of the limiting use of storage batteries in small central stations. The question is not without interest. The conclusion arrived at by Mr. Ferguson is, that if the duration of the peak of the load curve is more than 1½ hours, it is cheaper to instal extra machinery to meet this than to use a storage battery. He bases his opinion upon the assumption that the rate of discharge of a storage battery is four times greater if discharged in one hour, than if the discharge has to be spread over eight hours, and that the discharge rate is proportionate at intermediate periods for discharge.

He then says that the cost of a storage battery suitable for a small station, say, one of 500 amperes discharge at the one-hour rate, would be at the various discharge rates somewhat as follows :—

When discharged in	1 hour	... ...	£16 per KW.
"	2 "	... ...	£23 "
"	3 "	... ...	£32 "
"	5 "	... ...	£48 "
"	8 "	... ...	£64 "

These figures include switchboard, end cell switches, and the battery erected complete, but do not include any extra cost for building, which he thinks might be practically neglected.

Mr. Ferguson then assumes £20 per KW. as a reasonable price for boilers, engines, steam piping, generators, chimney

and switchboard, and as £20 is almost half way between the assumed cost of battery per KW. for one hour rate of discharge and two hours, he arrives at 1½ hours as the limiting duration of the peak in which a storage battery may be considered to have an economic advantage in a small central station.

This is certainly new, and, we may be allowed to say, somewhat inconsistent with what has been found to be of practical value in the operation of small stations.

The hard and fast conclusion above referred to might obtain if the load curve of a small station could be taken uniformly to be of the following form :—

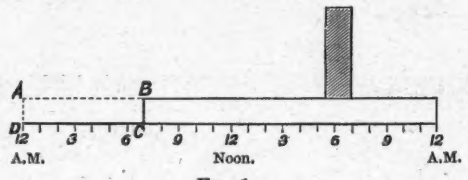
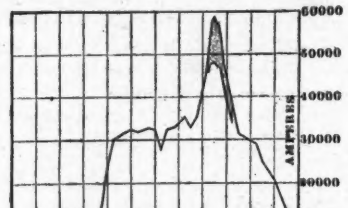


FIG. 1.

where the peak takes the shape of a chimney-stack and the area about 20 per cent. less than that of A B C D which represents the output of the plant during the hours when Mr. Ferguson assumes that the battery would be charged, and during which there is no outside demand. But, as a rule, a load curve does not take so simple a shape, nor is it of the same shape for two days together. For instance, if one of the load curves quoted by Mr. Ferguson, and reproduced in fig. 2, were a type of what might be expected in the small central station, it is quite clear that if the engine and dynamo plant were designed to deal with the load at A, it would be quite capable of charging a battery of sufficient capacity to supply not only the peak but also the demand during the hours of, say, 11 p.m. to 7 a.m. Mr. Ferguson himself draws attention in another part of his paper to the great advantage of a battery for taking up inequalities of load on long and short feeders, but he does not touch upon what is, perhaps, the most important



A, accidentally omitted; should be at the meeting points of lines 8 and 30,000.

FIG. 2.

function of a storage battery in a small station—next to supplying the light-load and peak—namely, to enable the supply to be continued in the event of a breakdown. In large stations where units are multiplied and several units of different size are kept under steam a breakdown can be dealt with instantly by a turn of a switch and the supply of current maintained. In a small station, however, the case is often very different.

Moreover, the capital outlay is not the only consideration to be kept in view when weighing the *pros* and *cons* of a battery installation. The cost of maintenance enters very largely in such calculations. For instance, the watt efficiency of a battery discharging in one hour is a very different thing to that which might be realised from the battery when discharged in eight hours, and the cost of renewals and upkeep are greater at high than at low discharge rates.

In concluding his paper, Mr. Ferguson states that "it is probably safe to say that there is no economical advantage—although there may be sentimental advantages—in the use of a storage battery in a lighting system where the average width of the peak of the load is more than from 1½ to 2 hours, although the battery may have a commercial advantage in ensuring the customers of the central station company a thoroughly reliable service with uniform quality of illumination."

It would thus appear that all Mr. Ferguson's argument may be said to amount to is, that in certain circumstances a storage battery might be desirable, while in others it might be dispensed with. With this most of us will agree, but what we shall find some difficulty in appreciating, is the exact shade of meaning which, in Mr. Ferguson's opinion, is to be attached to "economical" advantage as compared with "commercial" and "sentimental" advantage.

DEFICIENCIES IN CAR EQUIPMENTS.

By R. H. TWEEDY.

DAY by day we advance nearer to the time when English roads will be equipped throughout with English material, and everything which can help towards that end is worthy of assistance.

At present, however, as everyone knows, the largest portion of the rolling stock and equipments in use on British tramways is of American manufacture and design. We have, therefore, a very good opportunity for criticising current American practice, and if we consider the number of cars now running in the States, it is surprising how readily that practice lends itself to criticism.

There does not appear to be any probability that the general conditions of service on the other side differ so materially from the conditions existing here as to allow practices to be followed and materials to be used with impunity, which prove so untrustworthy when tried over here; therefore the same faults in design, manufacture, and arrangement of which we have to complain must have been met previously in the States, and should have been combated more effectively.

Practical experience shows that the time of the engineer responsible for the rolling stock—whatever title he may bear—is spent very largely in attempting to circumvent or anticipate faults which must have occurred wherever that particular type of equipment has been used, and which should have been provided for in any new design. Altogether too much time and money are spent in thinking out and adapting devices to overcome deficiencies which should have been eliminated long ago.

A few examples will illustrate the truth of these strictures. Every stationary motor in existence, to which the term modern can be applied, has its bearings lubricated continuously and automatically by means of some form of loose ring or chain revolving on the shaft, and some precautions are taken to prevent the oil creeping along the shaft to the armature windings and commutator. So far as oiling goes, practically no attention is necessary. Now the motor on a tramcar is worked under conditions which would make a stationary motor turn pale, and, on the face of it, one would imagine that at least as much care would be taken of its welfare. We find, however, that every advertised traction motor (I am open to correction) is provided with grease boxes over each bearing; rough-cast boxes with a slot at the bottom, and a lid held down by a spring. When the shaft becomes warm enough it is lubricated, but if by some mischance the bearing heats rapidly, one of two things happens; either the whole of the grease in the box melts away, or the heat is able only to excavate a kind of cavern in the grease, leaving, perhaps, as much as two-thirds unmelted and useless. In either case the bearing ceases to get lubrication when in most need, and the white metal runs; a mishap which may lead to worse, as the armature is likely to be let down on the bottom pole face.

A step in the right direction can be taken by fitting oil boxes into the existing grease boxes, arranged with an internal tube to take the usual worsted "trimming" of loco. practice. But lubrication by either of these methods is bad, if for no other reason other than that attention, and fairly constant attention, is required. If this attention had to be given only when the cars are in the sheds for the night, the case would not be so bad; but the boxes have to be examined three or four times in a 19 hours' day, which means that the

car floors have to be removed as many times, that the motorman risks his uniform or neglects his duty, and that passengers are kept waiting.

Surely continuous automatic lubrication can be applied to a traction motor. It is well worth doing.

At the same time that an efficient oiling system is devised, let some attention be paid to the problem of keeping the oil where it is wanted. It is a very difficult thing to prevent oil or liquid grease creeping, but it should not be more impossible on a traction motor than it is on a stationary motor or generator. Anyone not acquainted with the insinuating properties of oil would be astounded to observe how readily it creeps through a joint which seems perfect, and over obstacles revolving at a high peripheral speed.

Nothing but a razor edge will throw off oil effectively, and only a very well-caulked joint, or a joint into which a metal which expands on cooling has been run, will bar its progress. As it is of the highest importance that oil should not reach an armature, it is rather surprising that such half-hearted endeavours should have been made to avoid the evil. While oil does find its way on to the commutator, it is advisable to use moulded micanite rather than mica as the insulating medium—except, of course, for the inter-segment insulation—as oil finds a comparatively easy path between the laminæ of the built-up mica, and the insulation is broken down more quickly than when the solid micanite is used. Moreover, micanite is the cheaper, and is much easier to handle.

Owing to the conditions under which they work, traction motors are enclosed, but the majority are not enclosed enough. When cars come in after heavy rain it is the usual thing to drain quantities of water from the motor cases, varying from half a pint to a gallon or so. When parts of the road are covered with a few inches of water, it is not uncommon to find that the armatures have been actually running in water. Either armatures must be made to stand such treatment without breaking down, or motor cases must be made water-tight. The first remedy is impossible, but the latter should not be so.

Not nearly enough attention has been paid to the locking of the many fastenings of a car equipment. On anything like an old, badly laid, or badly maintained track, the vibration to which every part of a truck is subjected will inevitably tend to loosen any nut or pin which is not locked in some way. Every day unlocked fastenings are dropped on the road; every night they have to be replaced, and money is spent while men go round tightening up bolts with a spanner.

How is it that men do things on a tram-car which they would never tolerate in a station? Why is there so much wood about a controller? Why are 500-volt leads strung about promiscuously? Why is every possible electrical accessory hung up under the car-body, where water, and mud, and dust, can bespatter and cover them? Is there not ample room under the seats, or on the platforms, for resistances, lightning arresters, cable bundles, and what not? It would appear that cars are still designed by men who cannot get rid of the idea that horses are to supply the motive force. They seem to regard the electrical portion of the equipment as a minor kind of accessory, which can be stowed away anywhere, so long as it is out of sight. That is a very pernicious idea, and only time is needed to prove the right of any cable or electrical apparatus to break down if worked under any but the best possible conditions. There is no sound reason why all cables should not be absolutely protected, except perhaps the connecting leads between the motors and the car-bundles, which are under constant supervision.

What with cables, differing in potential by as much as 500 volts, bunched together, strung in the most exposed positions, barbarously stapled to woodwork, taken through rough drilled holes in vibrating floors without bushing, and led here, there and everywhere under the car-body, the whole thing strikes one as the creation of some jerry-wirer's delirium. Very generally the car-body and the truck are built by different firms, and the electrical equipment is supplied by a third, but the people who are ordering the whole know of what each part consists, and it rests with them to show the car builders what arrangements they must make for outside material. No car can be perfect till the underside of its body is absolutely free of anything connected with the electrical working. We may be permitted to hope that when British manufacturers do begin to turn out complete traction equipments in earnest, they will not allow records of practical experience, and their own common sense, to be pushed on one side by the desire to slavishly follow American practice, which is so much in evidence at the present time.

THE ELECTRICAL EQUIPMENT OF THE DISTRICT AND METROPOLITAN RAILWAYS.

There is no topic of public interest to Londoners which comes more frequently under the condemnation of the "man-in-the-street" than the persistent iniquity of the District and Metropolitan Railway Companies in failing to convert instanter their lines from steam to electric traction. He produces, or his recognised representatives produce for him in the daily and technical press, numberless reasons satisfactory to himself why such a conversion should have been accomplished at any time within the past 10 years. For is it not a fact, well known to him, that all similar railway services in America are operated electrically to the great comfort of his confrères in that delightful country, and to the profit of the stock holders? And is it not a fact also at home, right under his eyes, that the City and South London, the Waterloo and City, and now the Central London railways are all operated by electric traction? What possible cause therefore, he asks himself, except innate perversity can there be for the refusal of the plutocratic proprietors of our underground railways to convey to him the unnumbered blessings attendant upon the use of electricity?

It is true—and here the "man-in-the-street" snorts with indignant contempt—that the "fossilised" directorate of these two companies have had the audacity, before embarking upon the expenditure necessary to carry out his desires, to flout his opinion that "no difficulties exist" by expending some £20,000 in an "experiment" by means of which they could satisfy themselves and their stockholders as to the measure of the difficulties which do exist in the way of such re-equipment. But of what use are such experiments when the whole thing could be done instantaneously and without difficulty, as evidenced by the countless examples which he has well in his mind of similar undertakings successfully carried out in America and on the Continent any number of years ago?

Let us for a moment examine the position taken up by our friend in the street and his editorial representatives. The plain facts of the application of electric motive power for the operation of railways proper, as distinguished from tramways, are these:—In America there is only one urban steam railway system operating under conditions at all parallel to our underground lines, and that is the Manhattan Elevated Railway in New York. On the Manhattan Railway the difficulties of conversion to electric traction are considerably less than in the case of our London roads, since no "foreign" traffic passes over their lines. It will, therefore, at once be evident that in America, the home of electric traction, as the "man-in-the-street" well knows, the equipment of these lines should have been proceeded with at least 10 years ago. But what are the facts? The *Electrical World and Engineer*, of New York, just to hand, of date August 11th, states:—

"*Electric Traction on the New York Elevated.*—Important tests with the third-rail system on the lines of the Manhattan Railway Company will be made before October 1st. General Superintendent W. E. Baker, who has had charge of the electrical construction and equipment since the change in motive power was decided on, states that at least one trial train operated by electricity will be run over a section of the Second Avenue line by that date. It will be an experimental train, and will not carry passengers. The current will be supplied by the Metropolitan Street Railway Company."

It is, therefore, a fact that the only urban railway system in the United States that is at all comparable in its importance with our Metropolitan and District systems, is only on October 1st next to commence the operation

of a train which is no doubt to demonstrate in how far the practice laid down as the result of the operation of similar lines in Chicago, Brooklyn and elsewhere, may be safely followed for the equipment of so important an undertaking. The truth of the matter is, of course, that the directors of the Manhattan Railway Company, having had immediately at hand the results of the work which had been done in the equipment of the Lakeside, Southside, and Metropolitan Elevated systems in Chicago, of the elevated systems in Brooklyn, and of the Hartford and Newhaven Railway, have now decided that it will be safe for them to proceed with the equipment of their line. In other words, the development of the electric motor to a satisfactory stage has been supplemented by the working out of systems of train control and of distribution of power to a point where so large an undertaking, involving as it does an immense expenditure of the shareholders' money, may be proceeded with without undue risk. We know, as a matter of fact, that the capitalists who control the Manhattan Elevated Railway—some of them largely interested in electrical manufacturing companies—have kept the closest watch upon the developments in electric traction which they hoped would ultimately provide them with a more efficient system, and it is a sufficient answer to the criticism of the "man-in-the-street," or of others based upon "what has been done in America," that it is only within the past few months that the directors of this leading American railway company have felt themselves warranted in going in for electric traction.

Coming nearer home, and to what has been done in London itself, we are unable to see how the results obtained either on the City and South London, or the Waterloo and City lines, have any bearing upon the case of the Metropolitan and District Railways, unless, of course, one is prepared to ignore the axiom that all sound engineering is based upon a careful consideration of the local conditions of the particular case. Nor can the Central London Railway, important though this undertaking undoubtedly is, be taken as a demonstration of all the problems which are presented by the underground systems. The Central London is a comparatively short line, complete in itself, and constructed purely for working by electric traction. In designing and installing its electrical equipment there was no need to consider the fact that a heavy existing traffic must be continued throughout construction, and that other traffic besides it own must make use of the lines when completed. Even as it stands, just finished, and therefore presumably a perfect example of the art of the electrical engineer applied to heavy traction, there are those who severely criticise in many respects the practice adopted. It is by no means certain, keeping in view the fundamental necessity of a high speed schedule for lines of this class, that the adoption of the American type of carriage with doors only at the ends and with a necessarily increased stop at stations is not a great mistake; and whether also the use of a locomotive with its comparatively poor acceleration should not be considered out-of-date practice when compared with the enormous acceleration to be gained by a multiple control system with motors on each carriage and using the whole weight of the train for acceleration.

A word may be added as to the "experiment" which has so greatly excited the ire of the critics. We take it that sufficient ground for such an experiment from an engineering point of view would be found in the actual conditions of the case, but if not we are perfectly sure that, from the standpoint of the stockholders of the companies who, after all, are bound to be considered if only to a trifling extent, such an experiment was an exceedingly judicious proceeding on the part of the directors. It is fairly well known that the stocks of the two underground companies have been not more than ordinarily lucrative investments. The raising of the large amount of money required for the re-equipment by electric traction would therefore, one can fairly believe, only be reasonable to the shareholders when the success of such a re-equipment has been demonstrated as far as possible by an actual object lesson before their own eyes. As their money would be at stake, they would perhaps regard with a more sceptical eye than the "man-in-the-street" the glowing accounts which have come from America and elsewhere of the success of electrical re-equipment. They might even fairly ask for actual demonstration that such success was obtainable in their own case. We are inclined to believe that, failing such a demonstration, both the shareholders and the investing public would show some reluctance to come in with the money necessary for electric conversion, and that in such a case the cost of underwriting to obtain it would amount to many times the much-criticised expenditure on the equipment of the Earl's Court and High Street, Kensington, portion of the line.

THE ELECTRICAL ENGINEERS IN PARIS.

On Thursday of last week the London Institution of Electrical Engineers, and the American Institute of Electrical Engineers, held a joint meeting in the American Pavilion at the Paris Exhibition. The subject for discussion was "The Relative Advantages of Alternate and Continuous Current for a General Supply of Electricity, especially with regard to Interference with other Interests," and about 50 members of the London Institution were present at the meeting. There were a good many speakers, English, American and French, and though several contributed much information of an interesting and valuable character, it was, of course, natural that in talking on a subject of the kind, there should have been a good deal of drifting. Possibly for the purpose of eliciting information of a miscellaneous character, which later could be utilised for the purpose of arriving at some general conclusions, no better subject could have been chosen; but the conclusion is not yet, and in all likelihood there will be a good deal more interference with other interests in one way or another before any very definite solution to the problem implied by the title of the discussion will have been found.

Amongst the other interests referred to, were those of the gas and water companies, and the question was raised as to whether it would be possible to supply the requirements of the future by continuous current without seriously interfering with those interests consequent on the electrolytic action which might be expected to take place when large currents were used. It did not appear that any speaker furnished evidence of serious action of the kind having taken place up to the present, so that the speeches were more or less in the air, while Prof. Ayrton produced evidence to show that electrolytic action could be very well produced by alternating currents as well as continuous. This tended to level the two systems on one point at least, and it must be remembered that the object should be to eliminate all the differences with respect to the interference of the different systems, or if this cannot be done, to arrive at some idea of the cash value by which a system is depreciated by reason of the interference incidental thereto. It does not appear, however, that electrolysis cannot be guarded against successfully, though it is possible, of course, that to do so considerable additional outlay might be necessary.

The interference with the interests of the telephone companies next came in for a share of attention. It was remarked by Sir William Preece that telephone circuits with metallic returns could always take care of themselves, and that the working of these had never been detrimentally affected by alternating currents; he wished to state, however, that there had been occasional trouble with alternating currents due to these affecting the block instruments on railways. This trouble only took place when some accident occurred on the alternating circuits, so Sir William left the meeting in doubt as to whether an accident on a continuous current circuit might not affect the instruments just as badly. For such a discussion we wanted, above all things, results obtained from practice, but these were not forthcoming. A good deal of surmise and opinion there certainly was of undoubted value, but there seems to be little basis of direct comparison existent, as it is difficult to cite two installations on the alternating and continuous systems in which are present to the same extent the particular interests which are liable to be interfered with.

It was only to be expected that the Board of Trade regulation for permissible drop on the return circuits of electric

tramways would come in for some criticism, but on the whole it was of a favourable kind. The regulation was very necessary in the interests of people who had to put under ground ironwork representing an enormous capital outlay; it did not press unduly on the electrical industry, and seemed all round about the best rule that could be made to suit all reasonable persons. This opened the door to a discussion as to whether professors who wanted regulations such that there would be no kind of interference with their delicate measuring instruments, could be included in the category of reasonable persons, and the impression seemed to be that they could not. However, they are fortunate so far as London is concerned, in that they have got the London Tramways Company to divide their lines up into one-mile sections, and guarantee a difference of potential under the figure which will affect the instruments.

That submarine cable signals can be affected by the earth currents from electric tramways in their vicinity has been demonstrated on several occasions, but that effective means can be taken to neutralise their influence is well known. It should be remembered that all the difficulty about interference arises from the fact that for each undertaking the right to the use of the earth is claimed by the parties interested, and the unfortunate thing about it is that they cannot peg out their claims and keep inside them. An electric tram miles away will play havoc with the instruments in an observatory; the leakage currents from a light railway will find their way to sea and upset the cable signals. If the boundary of influence could be clearly defined, and the disturbance under all circumstances accurately predetermined, all might be well, but as it is, the only way of getting rid of all difficulties would be to preclude the tramway companies from using the earth as a return, which, after all, would be no great hardship.

It will be seen from the foregoing notes that, with regard to interference with other interests, the discussion did not show that between the alternating and continuous currents there was any particular difference, and this makes it all the easier to arrive at a decision as to which should be adopted. Assuming that with regard to other interests the systems have settled their differences, the question as to whether one or other shall be adopted is merely one of annual capital charges combined with running costs, and is largely determined by the size of the area to be supplied. In this country we have arrived at a pretty general rule for the generating pressure for alternating and continuous currents respectively, the former being 2,200, and the latter 440 volts, or the ratio of one to the other is, say, five to one. It is only by assuming a definite area and working out the cost on each system, that we can make exact comparisons of first and running costs, but it is generally agreed that for a compact, thickly-lighted area, continuous current is superior, while for a straggling, thinly-lighted district, the alternating current possesses considerable advantages. This means that there must be some one particular size of area and distribution of lighting, which can be carried out as advantageously on one system as the other, where in fact the area gets too small for alternating current, and too large for continuous, and it would be interesting to determine what sort of area this is.

Taking the matter of cables, the cost of the distributors might not be very different for the A.C. and C.C. systems, but with regard to the feeders the case is very different. For the same full load loss there would have to be some 25 times the copper in the C.C. that there is in the A.C. feeders, and the conductors would be more expensive in consequence, but as a set-off against this there is the cost of the transformers to be added to the latter, with that of any regulating gear interposed before getting to the distributors. Of course, one never makes the loss in the feeders the same in both cases, so one never uses 25 times the copper. The consequence is that the full load loss for the C.C. may be three times that of the A.C., disappearing altogether at no load, while, on the other hand, the loss in the transformers going on all day, whether the mains are loaded or not, has in the A.C. system to be reckoned with. It is obvious that when the area is so small that no feeders at all are required, as apart from distributors, the advantages are wholly on the side of the continuous current; when the area is extended so as to render feeders necessary, the matter has to be considered *pro* and *con* for every case.

It is somewhat curious to note that *the* advantage above all others which is claimed for C.C. working, namely, the possibility of storage, was scarcely, if at all, referred to. No doubt our friends from the other side accustomed to high stations look upon accumulators as only fit for toy works, as was remarked by Mr. Siemens many years ago. At any rate, several engineers are now beginning to realise that only in the initial stages of their undertakings do accumulators save anything in running cost, and sometimes even that is very doubtful.

There was no discussion as to the relative merits of single, two, and three-phase currents for a general system of distribution in towns. For one thing it was not the subject, and for another, the American engineers seem to be extremely cautious about expressing an opinion. But we are almost sure to have an important matter of the kind dealt with at a home meeting of the Institution before long.—W. B. E.

THE PARIS TELEGRAPH FETES.

[FROM OUR SPECIAL CORRESPONDENT.]

First Letter.

PARIS, *August 20th.*

THE *fêtes* organised by the French Postal Administration in honour of the Telegraph Service opened yesterday in magnificent weather. Some unfortunate events have recently conspired to rob the event of some of its beauty and importance. The final circular explains that, owing to the tragic event which has occurred in Italy, and the death of M. Gabriel Mougeot, the father of the esteemed Under Secretary of State for Posts and Telegraphs, which occurred but a few days since, some of the functions have been struck from the list. The reception at the Hotel de Ville and the ball at the Ministry of Commerce are among the erased events.

Yesterday the reception was held at the Ministry of Commerce, 101, Rue de Grenelle, and this again suffered through the absence of the Minister, M. Millerand, who was retained at the bedside of his little son, who is lying seriously ill at Trouville.

At the reception, some idea of the number of delegates was obtained. There are in all some 830 delegates, of which nearly 200 are foreigners. The notable exceptions were Italy and the United States. In the case of Italy, the Italian Minister had, at the last minute, cancelled the delegation which had been nominated in consequence of the general mourning of the nation. The United States delegate was absent, but no reason transpired.

England was represented by a dozen delegates, among whom we noted the Postmaster of Leatherhead (Mr. Stewart), Mr. Heaviside, superintending engineer, Mr. Sawer, of Manchester, and the two delegates of the Telegraphists' Association (Messrs. C. E. Hall and C. H. Garland).

In the grounds attached to the Ministry, which are of considerable extent, the band of the 130th Regiment played a fine selection of music, whilst a further private band was playing in the dancing *salle*.

Punctually at 2.30 the reception began, the French delegates being received by M. Mougeot, representing M. Millerand. At 3 o'clock the foreign delegates began to arrive, and a most animated scene presented itself. Uniforms of many descriptions were to be seen among the throng, and all the civilised languages could be heard. Shortly after the entry of the foreign delegates, an announcement was made of the arrangements for the week. To-day (Monday) was occupied by visits to the principal galleries of the Exhibition. To-morrow (Tuesday, 21st) there will be a special representation of selected scenes from many light operas at the Opera Comique. This will take place at 1 o'clock. Wednesday promises to be the *pièce de resistance*. At 8 o'clock an embarkation for Saint Cloud will take place, the boats starting from the Pont Royal on the right bank.

On reaching Saint Cloud, a trip will be made round the Park, and then a special train will convey the "Telegraph Army" to Versailles. Lunch will there be served, after which visits will be paid to the Chateau, the Park and the Trianons. The Mayor will hold a reception in the Town Hall, and the delegates will then return to Paris by special train to attend a *fête* organised in their honour at the Exhibition. On Thursday visits under special guidance will be made to the central offices of the Post, Telegraphs and Telephones, and in the evening a further special theatrical performance will be given. Friday will see a continuation of the detailed visits to the principal offices, and during the evening a further *fête* will be given at the Exhibition. Saturday being the closing day of the celebration, a dinner will be given at the American Restaurant in the Exhibition, when it is anticipated M. Millerand will speak in farewell to the delegations.

Each delegate has been supplied with a card of entry to the Exhibition, and very beautifully-designed enamelled badges bearing the inscription, "Postes, Telégraphes, Paris, 1900," in gold on a white band have been presented. The delegate's card gives the right of admission to all the public buildings, several balls and theatres in the city, and a reduced tariff for every place of importance either in or out of the Exhibition.

The immense number of delegates must make the task of entertainment an exceptionally difficult one for the Organising Committee, and every credit is due to them for their work and the successful result which bids fair to ensue. It will, however, be a matter for much regret if some opportunity is not given during the week for an exchange of views by the various delegations. So unique and important an event as the bringing together of postal and telegraphic representatives from all European States, will be without effect and utility unless an opportunity be offered for something more than an exchange of greetings and courtesies.

During the night a heavy thunderstorm and a deluge of rain broke over the city, and continued for some hours into the day, thus spoiling in some part the enjoyment of the delegates. But despite this the majority of them could be distinguished by their badges in the Exhibition grounds. Every detail for their comfort had been studied, and the greatest attention was shown to them by the officials and the exhibitors. The officials of the Administration, wherever encountered, placed themselves readily at the disposition of the visitors, and a most enjoyable and interesting day was spent.

It is stated, we cannot say with what truth, that there has been some considerable internal friction, which has militated greatly against the even greater success of the *fêtes*, and we have already heard accounts of a conflicting nature from adherents of the several cliques. It seems evident that the democratic and socialist principles of the Minister have been at the bottom of the difficulty. What is spoken of as the *bourgeois* element of the Administration, which is extremely anti-Liberal, has been intriguing to prevent the more Liberal and democratic element from obtaining any power in the arrangements in consequence of the leanings of M. Millerand. Thence has arisen a series of attacks and counter-attacks in the service organs of that vitriolic character that is common to French disputes. Such disputes are hardly edifying to the foreign delegates, and the free talk and circulation of the papers seems to us to be lacking in dignity and a necessary reticence. Other places, other manners; and the violence does not appear to mar in any serious way the cordiality of the reception. Vitriolic language does not seem to burn in France, the long use has robbed it of its fire. So we must accept these differences as a "custom of the country" and take the good the gods send us.

CORRESPONDENCE.

Current Specifications.

As a reader of your valued journal and an admirer of the usually impartial way matters are commented upon, I cannot help expressing some surprise at the manner in which your criticisms on the above are made, and which might reasonably lead one to suppose you held a brief for the so-called "professional consulting engineer."

In looking over your comment on "Current Specifications" contained in your issue of the 10th inst., I am astonished at the way you speak of "another instance of the tendency of public authorities to entrust the work of extensions into the hands of resident engineers," rather than employ the "professional consultant responsible for the original design."

I contend that the plan adopted by Torquay and many other towns is the better and more economical method of carrying out work, whether it be a new design or an extension of existing works, from the standpoint that a resident engineer must be in a far better position to know his own local requirements than a "professional consultant" called in to advise at the moment; and again, the resident is mainly responsible for the success of the plant when installed, or he loses the possibility of any remuneration for the extra work, and also his position as resident engineer, which may mean ruin.

I regret, however, to find that the clauses you take exception to, have been reproduced from the specifications for the original design.

I can quite understand and agree with public authorities employing their resident engineer for their works when his capabilities have been fully tested, rather than to call in a more or less eminent consultant who may spend the public money for experience, then pocket his fee and leave the plant in the hands of his clients whether suitable or not.

I should say happy the authority having a "resident" capable of carrying out extensions, and who has the courage to entrust such to him.

An Observer.

Torquay, *August 18th*, 1900.

[The sentence referred to by our correspondent was given as a *statement of fact*, not as an *expression of opinion*. We hold no brief for "professional consultants" or anyone else, and have never recommended the employment of different "eminent consultants" for successive extensions at the same stations. When first extensions are required, it is a question of policy for the owners of the station to decide whether to employ the consultant responsible for the original design, or to entrust the work to their resident engineer. Valid reasons can be adduced for either course, and local considerations often determine the one adopted. We object to the provisions in the clauses criticised and not to their authorship, which in our opinion is beside the question.—Eds. Elec. Rev.]

Conduit v. Trolley.

Your interesting article on the question of "Conduit *v.* Trolley" may be summed up as condemning the former on the score of (1) Capital cost of the conduit (*per se*); (2) Capital cost due to interference with gas and water mains, &c.; (3) Capital cost due to interruption of traffic while the conduit is being laid; (4) Cost of maintenance due to inaccessibility; (5) Liability to interruption due to accumulations of road silt and dirt in the conduit; (6) Liability to interruption due to leakage during heavy rain storms.

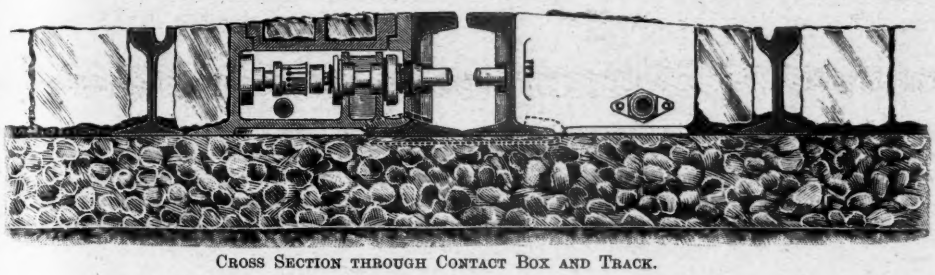
Your article was, on the whole, not unfair, in so far as it applies to the ordinary type of conduit, and it is this which leads me to hope that you may consider this letter, and the accompanying drawing, worthy of insertion in your journal.

The conduit shown is one on which you will see, from the enclosed circular letter (sent for your private information), I am endeavouring to get a crucial test made, and I claim for it that, as regards the above objections, (1) is practically halved; (2) disappears; (3) almost, if not quite, disappears; (4) remains, perhaps very little altered; (5) practically disappears; (6) also practically disappears.

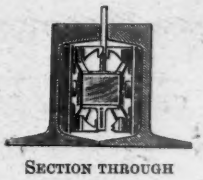
With regard to (5), it is necessary to explain that the principle involved is, that if we can have a perfectly uniform conduit, broken only when over a sump (as shown), *i.e.*, about every 200 yards, or less, according to locality, and if we can sweep through this length of conduit every few minutes, there is no *chance* of any serious accumulation of road silt and dirt. By employing a conduit of the form shown, and by attaching a steel wire brush to the plough of the car, the above conditions can be attained. The sumps should be amply deep, and with an overflow to the gullies

at the side of the street. There is *no continuous* drain under the track.

No doubt there are both electrical and mechanical difficulties in the construction of the plough required to operate such a system, but I claim to have solved some of the worst of these (see patent herewith), and it must be borne in mind that if the plough is the most likely part to get deranged, it is also the *most easily inspected* part of the whole system. It can be disengaged from the car within a few seconds when the car is in the shed, and removed for inspection, cleansing, and testing. It can also be equally quickly disengaged for inspection on any part of the route, and as easily picked up again. In other words, the weak part of the system is transferred from the conduit to the car shed.



Cross Section through Contact Box and Track.

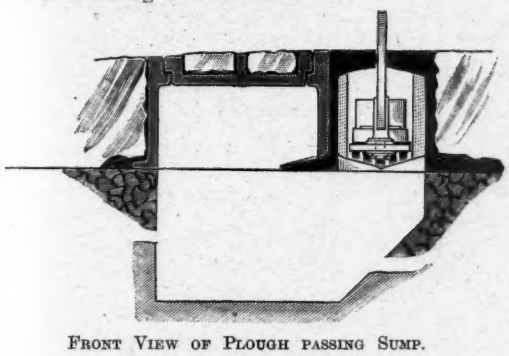


Section through Plough and Conduit.

As regards electrical difficulties, one of my patents deal with a construction of plough designed to enable cars to work through the worst weather—even when the whole street is under water. The leakage is, of course, confined to that part of the conduit underneath the car.

Full-size drawings have been made of the plough and other parts, but the enclosed drawing illustrates more particularly the advantages claimed for the system.

The system will allow of a ¾-inch slot being employed, with a liberal margin for clearance.



Front View of Plough passing Sump.

The system is, of course, *absolutely safe* to the street traffic under all circumstances; and there should be no possible opportunity for electrolysis of gas or water mains.

It is also worthy of note that the steel rails composing the conduit itself can be so designed that they will sell for a fair percentage of their original cost in the event of some other form of traction superseding the electric.

If our municipal authorities must have the conduit, let them have it in a form in which a considerable portion remains a marketable commodity, in the possible event of our present methods being superseded.

Conduit.

August 17*th*, 1900.

[Our correspondent has misunderstood our article. We refer him to p. 286 of to-day's issue.—Eds. Elec. Rev.]

I have read with interest your able editorial article in the last issue of the Electrical Review refuting certain statements made by Mr. Allen Baker, claiming the superiority and economy of the conduit or slot system as compared with the trolley or overhead system; the figures you give from actual working speak for themselves, without mentioning the many other drawbacks attached to an underground system. In this discussion of rapid transit by electricity for the streets of London and other large towns, I notice with some surprise that the question of electric traction by storage batteries is altogether ignored; yet when one remembers that such a system does not require the displacement of a single rail nor the removal of a single stone from the roadway, there can be but one opinion as to its being the ideal system for street traction. It will be said that accumulators have already been tried in London, Birmingham, and elsewhere, but had to be abandoned on account of their excessive weight and great cost for maintenance.

This so far is true, but we must not, however, altogether condemn a system by the failure of its early attempts.. The first attempts to light the City by electricity were certainly not successful, without speaking of similar attempts in Paris and elsewhere, yet what a world of progress has been achieved since then; so, too, with storage batteries, all those interested in traction by accumulators, have not remained idle after the failure to achieve a commercial success, but have rather turned their experience to good use, as will be seen if we compare the accumulators of the present day with those of 15 years ago.

In the attempts made in 1885—87 in London to run tramcars by electricity, four cars were drawn by small electric locomotives, each carrying 80 accumulators of the Planté type, 72 lbs. each, making a total weight of 5,760 lbs. The capacity of each accumulator was 100 ampere-hours at an average running current of 25 amperes, or four hours' run. Even with so much loss in carrying dead weight, the little engines did their work bravely, but as there were only four running alternately with horse cars, it was impossible to demonstrate the scheme from an economical point of view.

It is true that in the other attempts made, employing paste accumulators, the dead weight was reduced by about one-half, but these experiments only proved that paste cells were out of the question for that kind of work, owing to the enormous cost for renewal. Let us compare the weight and capacity of accumulators of the present day with those of 15 years ago; there are accumulators of the Planté type with a capacity of 100 ampere-hours weighing 18 lbs. (against 72 lbs. in 1885) which in a car would make a total weight of 1,440 lbs., instead of 5,760 lbs., the cost of manufacturing which accumulators has been reduced 50 per cent., naturally reducing the cost of maintenance on the same scale.

For the system of electrical tramcars in Paris, which are running successfully by accumulators, a mixed type is used, a Planté positive and paste negative, as it has been proved that those Planté positives last three times as long as a paste one.

Why should not London also have its lines of electric tramways by accumulators? There are at present accumulators that would enable a system to be run on a good commercial basis, and once running, any improvement that may be brought forward in accumulators could easily be adapted; it would only be a question of renewing with plates of the latest improvement.

C. P. E.

London, *August* 20*th*, 1900.

W. J. Davy Enclosed Arc Lamps.

The secretary of the Jandus Company, in his letter published in your issue of the 17th inst., displays a touching solicitude for the Jandus licensees, but it seems to me that his anxiety might well have been limited to his own company.

The extraordinary, but unsuccessful, efforts which Mr.

Gillies is making to explain away in the press the abandonment of the Jandus Company's action against me is proof, if proof were needed, of the hopelessness of his company's attempt to justify their allegation of infringement.

Inasmuch as his letter has been interpreted by some of my customers and friends as a threatening one, and as such is calculated to injure my business, I beg you will let the facts speak for themselves.

While I can understand that the truth that the Jandus Company have "wholly discontinued" their action against me may be damaging to that company, I cannot possibly see where the injustice comes in.

In the latter part of last year the Jandus Company commenced an action against me alleging infringement of certain of their letters patent, and claiming an injunction, damages, and delivery of the lamps made in infringement.

My defence was that I had not infringed their letters patent.

While the matter was before the High Court, the Jandus Company repeatedly applied for extensions of time, and apparently exhausted every possible legal method of postponing the date when the action could be set down for trial, and as they failed to set down the action for trial within the extended time allowed, an order was made dismissing the action, and in addition, on June 22nd, the Jandus Company served notice (a copy of which I enclose) "wholly discontinuing the action."

Prior to serving the notice of discontinuance, repeated efforts were made by, or on behalf of, the Jandus Company to induce me to accept a license for a merely nominal consideration, or on a basis of a "union of interest." I absolutely declined to do anything that would involve my accepting, either directly or indirectly, a license from the Jandus Company.

No proceedings in the nature of a test action or otherwise are at present pending against me. What the intentions of the Jandus Company may be in this respect I neither know nor care.

The Jandus action against Johnson & Phillips is in no sense parallel with their abortive action against me, for I never was, and never shall be, a licensee of the Jandus Company.

William James Davy.

UTILISING THE WASTE HEAT OF GAS ENGINES.

It is known that of the calorific power of the gas admitted to a gas engine, about one-fourth is sent adrift in the exhaust gases and a half in the water jacket, leaving a fourth in the shape of mechanical energy. In a steam engine about half the fuel energy reaches the engine, and the engine does well that does not throw away four-fifths of this half. The steam engine exhaust can readily be used for heating purposes if there is a demand for such heat, but very little has so far been effected in this way, and there must be an immense tonnage of coal used in domestic heating that might be replaced by the use of hot water pipes fed by the waste heat from engines. Under the circumstances, the paper of Mr. A. D. Adams in the *Engineering Magazine* seems almost unnecessary, for it deals with the more difficult task of using the waste heat from gas engines. To utilise such heat the means employed must not prejudicially affect the working of the engine.

Mr. Adams considers that the brake-horse-power of the gas engine represents about 18 per cent. of the total energy of the gas, and he apportions 37 per cent. to the exhaust, and only 40 per cent. to the jacket, the remainder to radiation. It is suggested to add the exhaust heat to the jacket water as far as possible, and to use this to warm buildings. This is considered practical, because the exhaust is usually much hotter that the jacket, which latter must be fairly cool, because of lubrication of the cylinder it cools. Jacket temperature appears to be about 150° F. Something like 1,028 heat units are necessary to raise a pound of water at 150° to steam at 212°, so that only one-tenth of the jacket water could be employed if steam heating is to be employed, and only half of the waste heat could thus be circulated. It is thus estimated that hot water should be the sole vehicle for the heat. In such a system the jacket water would pass through pipes exposed to the hot exhaust products, and thence to radiators or other heating or rather cooling surfaces, and so back to the jackets.

The efficiency of heat-absorbing surfaces depends much on the temperature differences. The temperature of the engine exhaust is somewhat uncertain, but is estimated at 1,050°. Feed heaters of the economiser type tell us that water can be heated to within 150° of the gas temperature. Such a temperature should be selected for the water leaving the gas heater that it will again reach the jacket at a certain point below 150°, and at the maximum flow will leave the jacket at 150°. By lowering the gases to, say, 350°, or through 700°, they will part with two-thirds of their heat. Two-thirds of 37 per cent. is about 24 per cent. Adding this to the 40 per cent. in the jacket gives a total of 64 per cent. of the total waste heat. Thus the cylinder supplies 62 per cent. of the heat put into the water, and the exhaust supplies 38 per cent. of it.

If the radiator system reduces the temperature of the circulating water 100°, such water should enter the jacket at 150°—62°, or 88°, and should leave it at 150°, after which it then leaves the exhaust heater at 150° + 38°, or 188°, and so on for other ranges of temperature of the radiator apparatus. Each square foot of such surface is allowed to dissipate two units of heat per hour for each degree of difference of temperature between the water and the surrounding air and a drop of 40° in the water temperature. The radiator has thus an average temperature on the assumption of a drop of 40°, of $\frac{125 + 165}{2} = 145°$. If a room has a temperature of 70°, each square foot will thus dissipate $(145-70)\ 2 = 145$ heat units. Ordinary radiator practice shows a drop from 210° to 190°, and a result of $(200 - 70) \times 2 = 260$ units, or 1·73 times that of the gas engine system, and so much more radiating surface must be suppied for equal duty.

It is pointed out that if the engine jacket can be allowed to attain 210°, the engine economy would be improved, and less radiating surface would be required. About 60 square feet of surface is necessary for each horse-power, and about 10 heat units per hour for each cubic foot of space warmed may be assumed requisite, so that 910 cubic feet may be warmed for each horse-power of engine. Thus about 10 H.P. would warm the four best rooms of a £50 or £60 London suburban house. Probably this amount of heat would suffice in England for the whole house, for the author is writing from American ideas of heating and a colder climate also. If 1 H.P. is obtained with the gas equivalent of 1 lb. of fuel, two-thirds of this goes to warming, so that practically our assumed house is warmed for about 7 lbs. of fuel per hour, or, say, at the least 70 lbs. per day, on the assumption that heat is not used all through the house all the 24 hours. At 20s. per ton this would cost barely 8d., or less than 5s. per week. Probably half this would serve as the year's average, or, say, 3s. per week, or £7 10s. per year. But the heat is now wasted, and could be profitably sold from a lighting station at a less figure than this.

The writer suggests that hot water might thus be circulated publicly through mains laid in the streets, with, of course, return mains, the circulation being maintained by pumps also gas actuated. If clean, such water could be drawn off for domestic use, though probably it could be better used to warm water drawn from the usual supply main by a coil heater. Four per cent. of the power of a gas engine might be lost by back pressure in the exhaust heater, but the extra gas to produce this power would give a better return than the same value of coal used for heating in the ordinary way. Obviously, the chief difficulty with such a system is that there will be a large winter maximum and a very small summer demand; but this difficulty appears much less in view of the fact that in summer there is also a minimum supply of waste heat from a lighting station, and it is such stations that are the largest fuel users. There would be more or less parallelism in the demand curves for heat and light, and where the demand for heat is in excess there would be no difficulty in meeting it.

Unfortunately, the principles and practice of common sense or real Socialism are so little grasped that these economics seem difficult of attainment. The ordinary idea of Socialism seems to be equality of condition for temperaments of different orders, or practical discomfort for all. The true article simply asks for the practice of those economics that are so obviously possible that only common sense is required to grasp them.

INDISPENSABLE ACCESSORIES OF ELECTRIC TRACTION.

By HENRY E. P. COTTRELL, A.M.I.C.E.

(*Continued from page* 242.)

Feeder Panels.—Each feeder connecting through automatic circuit breakers with board and with the main bus bar through quick-breaking knife switches. For light currents where fuses are substituted for circuit breakers, these are arranged so as to render arcing impossible and so as to be easily replaced. To each feeder circuit a maximum recording ammeter, and to each group a recording wattmeter.

Output Panel.—One main ammeter recording the total current output; one main wattmeter recording the total energy output; one main voltmeter corresponding to the main ammeter; one station clock.

Leakage Panel.—One recording ammeter reading up to one-tenth of the average output; one recording voltmeter reading 0 to 10 volts; one sensitive ammeter with two scales, one reading from $\frac{1}{50}$th to 2 amperes, the other from $\frac{1}{2}$ to 10 amperes, with a suitable switch or plug to alter connections to either scale; one current direction indicator; earth plate plugs or switches to place these in circuit with recording ammeter; ditto for overhead line to place it in circuit with low reading ammeter or generators to test for insulation; ditto to connect main feeders with low reading ammeter.

Equalising Panels.—An automatic circuit breaker, with connection to the positive pole of generator and the equalising bus bar. Generally all voltmeters, ammeters, and wattmeters are dead-beat instruments with illuminated dials.

Connections.—All cables leading to and from switchboard to have a minimum insulation resistance of 1,000 megohms, and under no circumstances are positive and negative connections to be allowed to cross.

Additional Instruments (in test room).—One portable voltmeter for connection with the terminals of a generator when running under working conditions; one Thomson reflecting galvanometer rated at 10,000 ohms resistance, and coils with differential connections with or without induction shield; one D'Arsonval galvanometer rated at 2,000 ohms; one four-section 100,000-ohm coil and shunts of $\frac{1}{3}$th, $\frac{1}{99}$th, and $\frac{1}{999}$th for both galvanometers; two portable plug Wheatstone bridges rated at 10,000 ohms with coils ranging from ·1 to 10,000 ohms; a condenser, two standard Clark cells, and a standard megohm; a single key, a discharging key, and three double reversing keys; a battery of 150 Leclanché cells fixed on shelf completely and thoroughly insulated from all surroundings. For the galvanometers a pier entirely isolated from all vibration carried down below the main foundations and with cap laid on felt or rubber is provided, and the switchboards connected with the test room through wires of extremely high insulating resistance, run on insulators and fitted with terminals.

Switchboards.—These formed of panels bolted together by their angle iron frames rest on a wooden beam, to which they are bolted by the bottom angle iron, forming part of the floor, their tops being fastened to the wall by insulated tie rods. Over 40 inches space is allowed behind the switchboards for making connections which are all clamped connections at back of board. Where bus bars have to be connected they were first rivetted and then soldered and sweated together.

The position of the switchboards is determined in each case subject to local conditions in such a way as, first, to be easily reached and seen from every part of the station; second, to have all the connections easily accessible for testing; third, to make all generator leads approximately equal and of minimum length; fourth, to permit the field magnet winding to be always on the positive side of the armature.

Overhead Trolley Wire.—In a previous portion of these articles the accessories connected with the "return" or inward circuit have been considered; in the present portion it is proposed to similarly consider those connected with the "going" or outward circuit. There are two ways in which this circuit may be provided, first, by overhead conductors or the trolley wire system; second, by under-ground conductors or the culvert system. The first system is by far the most usual all over the world, chiefly on account of the relatively excessive cost of the culvert system. On this side of the Atlantic this great difference in cost has contributed, to a very considerable extent, to delay the adoption of electric traction on tramways, the unæsthetic looking overhead conductors and their supports being held to be out of the question. Strange to say, the effect of the unæsthetic reputation attaching to overhead conductors has been most seriously felt in England where the cult of æstheticism is most certainly less ostensible than on the Continent, and has considerably less *raison d'être*. However, this may have arisen, luckily for town locomotion in the immediate future, this more or less unreasonable prejudice against overhead conductors has at last been broken down, and the introduction of electric traction need no longer be hampered on account of the supposed unsightly look of the above-ground installation.

Trolley wire is now practically always made of hard drawn copper with a conductivity of 0·98 of that of pure copper, and a tensile strength of some 60,000 lbs. per square inch. The sectional area of trolley wire must be directly proportional to the amount of the current it has to carry to avoid loss of potential in transmission through heating of the conductors. The element of the strain due to length of spans (Board of Trade standard = 120 F.), and the effect of temperature upon the length of wire has also to be taken into account so that the strain shall at the lowest temperature not exceed a maximum of 2,000 lbs. on the usual size of trolley wire (O B and S G = 0″325 diameter). In England where 20° of frost may safely be considered a maximum, a practical rule for ensuring the non-exceeding of the safe tensile limit is to allow $\frac{3}{4}$ per cent. of the span as the normal sag at the average temperature of 60 to 65° F. These considerations bear directly on the weight of the trolley wire to be chosen, and therefore on the accessories that have to be selected for use with it. The form of cross section is also varied in accordance with the area of the cross section selected; wire required for small installations where the currents are small in quantity are invariably round, but for large installations, a bull-headed rail of figure 8 section and sometimes a trefoil section is selected. The quality of the trolley wire must be absolutely uniform, and it should be supplied in minimum lengths of half a mile; the joints should be silver brazed in the copper rod before final drawing; the limits of variation in diameter should not exceed 1/810, and the tensile strength should not fall below the standard of 60,000 lbs. to the square inch by more than one-fifteenth. There are two distinct ways of suspending the trolley wire. 1st, over the central axis of the track; 2nd, parallel to the track at a varying distance from the central axis. These two ways arose to suit two ways of fixing the trolley head or shieve holder at the end of the trolley pole. The first was unavoidable and obligatory when the trolley head was fixed, the second became possible when a swivelling head was invented. In going round curves a certain amount of deflection from a line coinciding with or parallel to the axis of the track in both ways of suspension is unavoidable, and the maximum amount of this deflection or off-set, and, therefore, the number of the points of support which have to be provided for the suspension depends in the first case on the limiting angle of inclination which the fixed shieve can assume with respect to the wire without leaving it (20°), which gives a maximum off-set of 3 feet 6 inches (2 feet 2½ inches being the maximum in usual practice) and in the second case this depends on the maximum overhang of the trolley pole (10 feet) beyond its base or pillar which is fixed

on the central axis of the car. The first examples of the second method of suspending trolley wires were afforded by the Bristol and South Staffordshire Tramways on this side. There are also two distinct methods of supporting the suspended trolley wire, the first is from span wires fixed to poles on each side of the roadway or to the sides of the adjacent houses, the second from brackets attached to poles or houses on one side of the roadway. The span-wire method was practically obligatory with the central-axis method of suspension, as otherwise the overhang of the brackets became excessive, but with the parallel method of suspension it has become largely optional and dependent upon exceptional local circumstances, as the overhang of the brackets with a limiting off-set of 10 feet from the central axis can generally be kept down to very reasonable limits.

The present neat and ingenious, and with all, simple insulating and supporting devices which the line erector has at his command, were like most other accessories connected with electrical traction gradually and slowly developed from crude adaptations of telegraph material with which the first linesmen had to meet the special requirements of trolley conductors. Each special point has now its appropriate device, the evolution of which has been chiefly due to the enterprise and inventiveness of the manufacturers on the West side of the Atlantic. As long as the materials used for various forms of line insulation were limited to porcelain, glass, and paraffined wood, very little progress was possible in specialising the forms of insulators. This specialisation only became possible when a cheap material of the character of the Aetna insulator was invented. This material is composed of ingredients which form a homogeneous mass susceptible of being readily moulded under pressure while in a plastic condition, the finished product being exceedingly tough, strong, resisting, impervious, absorbent and non-conducting, hard, fibrous and resonant, standing any amount of hard wear and tear and ill-treatment. The trolley wire is attached to the hangers by "ears" or clips of lengths varying from 7, 9, and 15 inches to as much as 36 inches in special cases. There are two types of clips or ears in use: 1st, the soldered type where the wire is soldered to the clip; and 2nd, the mechanical type where the wire is held between the jaws of two or more plates interlocked by bolts or wedges. It may be at once stated that the first type, although more costly to erect and taking more time, gives by far the best results so long as the soldering is effected so as not to permanently alter the character of the wire by annealing, as the clips whether they possess shallow or deep grooves, both of which types are in use, do not interfere with the running of the trolley shieve nearly so much as even the best examples of the mechanical clips; but this interference does not matter so much in the parallel system of suspension as it does in the axial, as in the former the groove of the trolley shieve is practically never inclined to the trolley wire at an angle which would materially assist the obstruction offered by the clip in throwing the shieve off the wire, as it constantly is in the latter, the inference being that the cheaper mechanical clips can be adopted with safety in the parallel system of suspension provided care is taken to so attach the wires to them as not to produce permanent kinks, which, in case the clips are shifted, should weaken or render the wire unfit for running.

Many special forms of soldered clips or "ears" are constructed for various special uses on trolley lines. They are all made of malleable cast-iron or bronze metal castings with the shallow or deep groove tinned ready for soldering.

1. Straight line ear.
2. Curve ear.
3. Splicing ear.
4. Anchor or strain ear.
5. Feeder ear.
6. Special section ears.

All these various forms of "ears" or clips are united to the insulated hangers by pins or bolts with ends that screw into a central socket. The pins or bolts alter in shape and dimensions, in accordance with the type of hanger used, but the clips remain the same. Of mechanical "ears" or clips, there are a vast number of types in use, none of which are quite as efficient as the soldered clips for axial suspension, but with parallel suspension they are coming more and more into favour for reasons previously alluded to.

The "Anderson" mechanical ear is a central bronze metal casting with a groove for the wire to lie in on its lower edge. Over this fits a bent plate or clip of hard rolled copper or iron with eyes which close over slotted projections in the casting, which is fastened in the ordinary way to the hanger. The eyes are forced over the slotted projections by a special clamp, then the screw bolts on the top of the casting are set up and the whole bound firmly together. It is both strong, durable, and easily applied.

Another favourite type is the "Badger mechanical ear," this is composed of two interlocking plates of malleable iron or bronze metal, which, when put together, leave a groove in which the trolley wire is clamped by the wedge-shaped stud of the insulator being forced into the jaws formed by the upper half of the plates. A pin through stud and ear fastens these together. The above examples are typical of most forms of mechanical ear, and they can be adopted to all types of hangers where the trolley wire is rolled into special shapes other than the usual cylindrical form, the mechanical ears are universally used even in axial suspension. A special form is used with sections of the double-headed type. This is a clip with groove corresponding with the smaller head of the wire which is set up with clamping screws after the wire is inserted.

Hangers can be divided into classes in accordance with the way in which the strain and the weight of the trolley wire is borne by the insulating material, the first being in tension and the second in compression. The following forms of hanger are in general use for line purposes:—

(*a*) Straight line hanger.
(*b*) Single pull off } Curve hangers.
(*c*) Double pull off }
(*d*) Bracket arm hanger.

Of the first type of hanger, the Ætna series, adopted on the South Staffordshire, Douglas & Laxey, and the Guernsey lines, afford very good examples. The mass of the head is composed of insulating material, at the centre being a thimble with a screw thread to take $\frac{7}{16}$ inch or $\frac{3}{8}$ inch studs to connect it with the "ears." Over the upper portion fits a cup-shaped casting with lugs of various shapes attached. This series of hangers are efficient and inexpensive, and well suited to light suburban and country lines where economy in first cost is a prime consideration. Of the second type of hanger, two well known forms are in general use on British lines, one known as the "West End" insulators, the other as the "Globe strain" insulators. In the first form the insulation is completely protected from rain or injury due to blows from the trolley head or arm, by the whole of the external portions being of a bronze metal. The insulated part consists of a steel pin or bolt heavily covered with insulating material, which is removable and interchangeable in the various forms of hanger, and for feeder hangers can be exchanged for a non-insulated pin as shown. The castings of the various shapes corresponding to those of the Ætna series are all made internally with a socket in which the steel pin previously described fits tightly; round the top edge are six lugs spaced equidistantly. After inserting the bolt a cap is screwed on provided with three fingers, which can be bent by hand so as to fix into the lugs in the top of the casting to prevent the screw caps from working loose with the vibration of the trolley wire and exposing the insulation to contact with moisture. Thus leakage through this cause is reduced to a minimum. One of the chief advantages of the "West End" type of insulator lies in the fact that the insulated bolt is wholly protected and cannot allow the wire to fall even if the insulating coating were to be wholly destroyed. This is not the case with the Ætna series, or with the "JA" and "Boston" insulators, in all of which destruction of insulating material involves the fall of the wire.

The "West End" series comprises also some special forms which are worth mentioning. One is a bracket arm double insulation hanger, which is used in all more recent installations, as affording more efficient protection against leakage. Others are special forms of "bridge" insulated hangers. One of these provides a yielding support to the wire so that the trolley head should not strike at high

speed a point without flexibility and have a tendency to run off. All are hangers to be fixed to overhead ironwork or masonry such as arches or girder spans, &c. The "West End" series of hangers have been adopted for the Dublin, Bristol, Coventry, Leeds, Isle of Man, Bradford, and Liverpool tramways. For special sections of heavy trolley wire the castings are made of heavier metal, so that any desired strength of hanger can be produced without alteration of form or dimensions. This has been done in Liverpool and elsewhere. There is a special tool for putting up these hangers where span wires are used. The castings are held in the fork while the span wire fits into the groove of the wheel, and a single movement of the lever snaps it into position.

Conditions.	Size diameters.	Description of metal.	Description of insulation.	Resistance under 6,000 volts, alternating current up to rupture.	Load in lbs. at which rupture occurred.	Nature of rupture.	Insulation now affected.	Remarks.
Ordinary service.	Small globe, 2 inches	Bronze	Ætna	∞	3,700	Eyes stretched, one broken	Unaffected, intact	A strain of 3,000 lbs. can be safely applied in all cases without in any way affecting the resistance of insulating material.
	do.		Hecla	do.	4,500	do.	do.	
	do.	Mall. iron	do.	do.	4,900 to 5,500	Metal intact	Broken	
	Medium globe, $2\frac{1}{2}$ inches	Bronze	Ætna	do.	5,000	Eyes stretched out.	do.	
	do.		Hecla	do.	5,400	do.	do.	
	do.	Mall. iron	do.	do.	7,200 to 8,300	Metal intact	do.	
	Large globe, 3 inches	Bronze	Ætna	do.	7,300	Eyes stretched out.	do.	
	do.	do.	Hecla	do.	8,000	do.	do.	

The "Globe strain" series of insulators, like the "West End" series, possess the advantage of securing the trolley wire from falling even where the insulating material, which here also is in compression, is destroyed.

In regard to the principle upon which these insulators are made; their resistance to tensile strains is most remarkable, as the above table will show, also the satisfactory character of the insulation afforded by these hangers under strains.

(*To be continued.*)

CYLINDER PROPORTIONS FOR COMPOUND ENGINES.

There are two schools of thought and practice on the subject of drop of pressure between the cylinders of compound engines. Some hold there should be no drop. They think that the cut-off in the low pressure or the next succeeding cylinder should be so regulated that there is practically continuous expansion, the one cylinder initial pressure being the same as the terminal pressure in the preceding cylinder. Mr. Ball, who recently presented a paper to the American Society of Mechanical Engineers on the subject of cylinder proportions, thinks that no drop is the theory of the older men, while the other school would allow drop on the principle that it is useless making steam by compression. This they hold is what has really to be done when all drop is eliminated. Probably the truth is to be found in compromise with a low pressure cut-off of about a half stroke.

Mr. Ball's paper is useful and interesting, and is, we believe, the first published in America to lay stress on the importance of reducing the internal areas exposed to differences of pressure and temperature in order to keep low the cylinder condensation. He recognises that the one reason why one engine is less economical than another working at the same pressure and range of temperature, is simply that the cylinders differ in their action on the steam

All the mathematics in the world are useless when applied to steam engine working until something more definite is known of this subject. Enough is known of it, however, to point clearly and absolutely to certain points necessary to be observed. The internal areas should be small; they should be clean and bright. Possibly they should be oiled. Here our knowledge seems to end. Nothing is known as to the effect of materials. Is there an advantage in, say, gun-metal over cast-iron, or does the reverse hold true?

Evidently the writer is of opinion that engines may easily be too big for their load. An engine designed for highest economy will not ordinarily have a very great overload capacity. Specifications often contain conditions that render it a practical impossibility for the engine under running conditions to give its best economy. Thus an engine is specified to give a 25 per cent. overload when run without vacuum, and a 40 per cent. overload when run with vacuum. Now an engine designed for an economic load with vacuum, could hardly develop its rated capacity without it, to say nothing of overload.

Non-condensing engines designed for 100 lbs. or less if economical, will not have much margin for overload. Hence a condensing engine that is to be run non-condensing must have its cylinder ratios considerably modified, or it must have a bye-pass to its low pressure cylinder. There is much truth in the above, especially for the irregular work of a tramway or railway, and it has often seemed to us that for such engines which fall below speed for their momentary maximum loads, if worked at all reasonably at ordinary loads, there should be a provision that a supplementary steam supply should be admitted to the low pressure cylinder, so that a fairly small compound engine should run, in a sense, as a simple engine over the peaks. We do not think any real effort has yet been made to test the relative efficiency of simple and compound engines on a traction load. It does not appear to us that the compound principle is put to its best use when applied to loads that are so variable that an engine must be so very much too big for its ordinary load in order that it may cope with its maximum duty. Practically, tramway work is run with engines which permit a cut-off no later than the equivalent of one-third of the low pressure stroke. In a simple engine the admission could be extended to three-quarters for the very occasional peaks, and yet the ordinary duty could be run at an early cut-off. It is quite an open question whether the compound principle is worth the loss entailed by the present system.

The general tenour of the paper is otherwise that excessive expansion does not make for economy, and that drop between cylinders is not necessarily to be avoided. It advocates, however, a considerable reduction of the capacity of the first cylinder of compound engines. Though by this plan the range of temperature will be increased in the second cylinder, yet the exposed area inside the first cylinder will be very much reduced, and it is exposed area that causes cylinder condensation.

It must always be remembered that the amount of steam that any compound engine can have fed to it is that which will fill the first cylinder at boiler pressure. This measures and limits the power of the engine. In a simple engine the limit of power is that obtained at maximum cut-off in the final cylinder. Thus the final cylinder of a simple engine can be smaller, and it will work at ordinary duty at better economy than the nominally more economical compound engine.

If this is so, the reason is not because compound working is not economical, but because it is not economical to run an engine underloaded. Large numbers of tramway engines run at less than 50 per cent. of their rated economy. In doing this they work at occasional maximum loads of 135 per cent. of their rated load, and must run for much of their time at very small loads indeed. Electric traction has been developed from electric lighting to some extent, because electrical men have naturally taken up the work; but the conditions are very different, and it is by no means certain that present practice is anywhere near finality.

BUSINESS NOTES.

Bankruptcy Proceedings.—The first meeting and public examination in *re* W. V. Scott, electrical engineer, East Hammersmith, are to take place on August 30th and October 16th respectively, at Bankruptcy Buildings.

Books Received.—"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Vol. xvi. London: Andrew Reid & Co., Limited. 1900.

"Programme of Technological Examinations at the City and Guilds of London Institute for Session 1900-1901." Whittaker & Co. 1s. net.

Hotel Cecil.—In consequence of the building of the north block, the electrical installation is being largely extended under the superintendence of the chief engineer, Mr. W. A. Poynton, A.I.E.E., and a fifth 75-kw. turbo-dynamo has been ordered from Messrs. C. A. Parsons & Co.

Electrical Wares Exported.

WEEK ENDING AUG. 22ND, 1899.		WEEK ENDING AUG. 21ST, 1900.	
Amsterdam	Value £20	Amsterdam	Value £115
Auckland	75	Beira. Teleg. mat.	4,510
Beira	1,577	Bombay	586
Bombay	69	Brisbane	125
Boulogne	25	Calcutta	600
Buenos Ayres	2,307	Cape Town	47
" Teleg. mat. ..	155	" Teleg. apparatus ..	150
Cadiz. Elec. machinery ..	240	Christiania. Teleg. wire ..	50
Calcutta	75	Durban	642
Christchurch	12	East London	895
Colombo	498	Foochow	18
Delagoa Bay	59	Fremantle	163
Durban	710	Gibraltar. Teleg. mat. ..	400
Fremantle	105	Hamburg	200
Grenada	213	" Teleg. mat.	250
Havana	20	Melbourne. Teleg. cable ..	1,206
Hiogo. Teleg. mat.	118	" Tramway cable ..	600
Liban	93	Port Elizabeth	160
Malta	10	Rio Janeiro. Teleg. mat. ..	142
Melbourne	60	Rotterdam. Teleg. mat. ..	250
" Teleg. mat. ..	2,193	Singapore	61
Odessa	15	Stockholm. Teleg. mat. ..	477
Ostend	148	Sydney	931
Penang	15	" Teleg. mat.	210
Port Elizabeth	142	" Tramway cable.	627
" Teleg. wire ..	483	Trinidad	45
Rio Janeiro. Teleg mat. ..	1,424	Wellington	223
Rotterdam	20		
San Sebastian	35		
Santos	20		
Singapore	107		
Stockholm. Teleg. wire ..	161		
Sydney	1,548		
Wellington	46		
Yokohama. Teleg. cable ..	95		
Total ..	£12,693	Total ..	£14,343

Foreign Goods Transhipped.

Calcutta. Elec. supplies.. Value £64 | Adelaide. Teleg. app's .. Value £70

Aron Electricity Meters at the Paris Exhibition.—Among the apparatus exhibited by the Aron Electricity Meter Company at the Paris Exhibition are the following:—Meter for registering charge and discharge of accumulators, in oak case, adding 10 per cent. automatically at charge for the efficiency of the battery, reading direct in ampere-hours, at a constant potential circuit of 230 volts, arranged for a battery of 50 amperes maximum discharge and 500 ampere-hours capacity. Direct current, 30 amperes 440 volts meter, in teak case, adjusted so that it is recording energy consumed by a lamp battery also at the stand. Ampere-hour meter for accumulator use, registering charge current on the one set and discharge on the other set of dials, reading direct in ampere-hours at a constant potential circuit of 220 volts, to carry a maximum current of 15 amperes. Maximum E.M.F. in series coil at supply tension. Prepayment hour meter arranged for a tension of 220 volts direct current, adjusted for 6d. per Board of Trade unit for 2-C.P. lamps at 220 volts with 6d. in the slot, in oak case. Hour meter recording the hours which a circuit is closed, adjusted for 220 volts direct current, in oak case. Day and night load meter, 15 amperes 110 volts. This instrument consists of, as well as the ordinary supply meter, an electrically-driven clock; by means of an adjustment the record of the energy made may be automatically thrown over from one set of dials to another during the course of 24 hours, so that during the peak of load consumers may be charged a higher price than during the rest of the day. Alternating current single-phase 30-ampere 100-volt supply type, in metal case, as approved by the Board of Trade, and as supplied for use in consumers' houses. Alternating current single-phase, in metal case with glass panels, as constructed for switchboard work for central station purposes, 100 amperes 220 volts 63 cycles. In addition to the above there is a lamp battery on slate with brass letters indicating the words "Aron Meter"; on the brass letters are mounted lamps, and the direct current instrument, mentioned above, is recording the current consumed thereby. The Aron Company claim that their instrument is the only meter approved by the Board of Trade in this country for all methods of distribution; while it is also claimed to be equally applicable for continuous, two-wire, three-wire and five-wire alternating current; single-phase, two-wire and three-wire, and two and three-phase methods of distribution. The instrument is stated to be as equally accurate on highly inductive as on non-inductive circuits, hence is particularly applicable for all power work. It is designed to record the whole of the kilowatt capacity of the circuit on which it is placed, the maker's greatest achievement in this respect being the registration of three-wire circuit 2 × 4,000 amperes, 2 × 300 volts. The instrument is claimed to be absolutely proportional throughout the entire range, and will register even to the leakage of the installation. It requires no attention other than being hung perfectly perpendicular by means of the plumb line. The energy consumed in the shunt is stated to be the smallest in any watt-hour meter on the market, and the drop of pressure across the series coil is inappreciable. All the meters on the board were constructed in the Aron Company's English factory.

Catalogues and Lists.—From Messrs. Schumann's Elektrizitatswerk, Limited, of Leipzig-Plagwitz, we have received a leaflet illustrating their cast-steel box motors, normal sizes of which up to 12 H.P. are always stocked.

We have received from the General Electric Company, Limited, a copy of the thirteenth edition of their electric bell and general catalogue. In 104 pages are included particulars of all varieties of electric bells and electrical signalling devices, batteries, and accessories. Many improvements have been introduced, but many of the prices are considerably reduced. In the "Indicator" pages every type of indicator, for ordinary house work, for ships, lifts, hotels, and, in fact, all positions where electric signalling is desirable, are described. In the pages devoted to contact-making devices, the multitudinous patterns of wood, china, brass and wrought-iron indoor and outdoor pushes and pulls have all been re-edited and re-arranged, many new patterns being introduced. The compilers of the list have aimed at facility of reference, brought about by clear arrangement of the illustrations and prices. The letterpress enables one to at once grasp the principles of the various accessories described and their application to the practical work of the installing electrician. Some diagrams of connections and circuits have been especially drawn for this edition. They are accompanied by explanatory notes and instructions for fitters.

The Ransome and Smith Company, of Brooklyn, have issued a new trade circular of the Ransome patent concrete mixers.

The B.T.H Co's. new pamphlet No. 73, describing direct-current carbon-feed enclosed arc lamps, supersedes No. 52 of December last.

Copper.—The last issue of Messrs. H. R. Merton & Co.'s statistical circular relating to copper shows that stocks have increased by 3,547 tons, and that prices have risen 20s. per ton during the first half of the current month. Supplies have reached 12,915 tons, to which total North America contributes 6,628 tons, or nearly one-half. The supplies from "other countries" total 2,709 tons, from Chili 1,400 tons, and from Spain and Portugal 1,278 tons. All of these amounts are rather above the average for previous periods of 15 days. The total deliveries during the first half of August, on the other hand, have only reached a total 9,368 tons—one much below the average for similar periods previous months of the year—and *no "standard" copper has been shipped to America.* The result is that supplies have exceeded deliveries by 3,547 tons, and that stocks have increased by this amount. The deliveries during the second half of the month are likely to bring the total for August up to the average figure of 22,000 tons. The movement of prices is independent of stock fluctuations, and is doubtless governed by possible future contingencies. Copper was selling for £70 per ton on Decemher 31st, 1899, when the visible stocks in Europe were only 22,817 tons, and for £74 on August 15th, 1900, when stocks are nearly 10,000 tons larger.

Directories.—The 1900 edition of the "Universal Directory of Railway Officials," published from the office of the *Railway Engineer*, Catherine Street, Strand, W.C., is compiled as usual from official sources, by Mr. S. R. Blundstone. The officials of all tramways in this country which are now worked by steam and electrical power are now for the first time included in the list of railway officials, presumably because the mechanical tramway is a street railway according to the general rule in America, and is becoming so here. No doubt there is much in common between the tramway and railway official. This addition gives an extra interest to the book, from an electrical point of view of course. In the section giving a few short details as to the officials, length of line, gauge, and so forth, railways and tramways are all mixed up together and arranged in alphabetical sequence. The ground to be covered is too great, perhaps, to allow of an additional section giving the electric lines separated from the trunk lines and other steam railways. The systems in operation on the European Continent, Asia, North and South America, in fact, of most foreign parts, are included, as well as those of our own little islands. An alphabetical list of names of all officials is given in the latter half of the book.

"Duncan's Manual of Tramways, Omnibuses, and Electric Railways" is familiar to most railway and tramway men, and the issue for 1900—the twenty-third annual edition—is now before us. As compared with previous editions, the present one is improved by the addition of the accounts of a number of electric railways and tramways throughout the country. Wherever the information has been obtainable, the receipts and expenses per mile run are given and the amount of capital, together with other figures showing the present financial position of the various undertakings stated. The Manual is published by T. J. Whiting & Sons, Limited, 7A, South Place, E.C. (3s. 6d.)

Electric Coal Cutting.—The Summerlee and Mossend Iron and Steel Company is introducing at its collieries at Preston Grange, Midlothian, electric coal-cutting plant of the Clark and Steven disc-cutter type.

Electric Cranes.—The Tees Union Shipping Company, Limited, have recently installed at their wharf at Middlesborough three portable electric cargo discharging cranes. The cranes, which have a power of five tons, have been constructed by Messrs. Stothert and Pitt, Limited, the consulting electrical engineer being Mr. J. G. W. Aldridge, of London. The Tees Union Shipping Company have already found the cranes most satisfactory, and on 3rd inst. the engineers (Messrs. Stothert and Pitt) invited a company to witness the working of the cranes at the Wharf, and afterwards entertained the company to luncheon at the Grand Hotel.

Electric Power Applications.—It is not necessary to write much nowadays to remind electrical engineers of the vast possibilities contained in the development of electrical driving by the application of motors. The partial success of the great power distribution schemes will be an untold benefit to the electric driving machinery industries, not merely in the actual work involved in their carrying out, but in the educational effect of the very important and practical evidence which was given by the leaders of engineering and other trades in the affected districts. The evidence was of such a character and so convincing in its terms that it should be placed in the hands of, and be fully digested by, every works owner or authority who now puts his trust in steam or gas for driving machinery. We rather think that consulting engineers and advisers who have electric driving work in prospect will not be slow to make use of such convincing testimony in the presence of

doubting Thomases. Those who are interested in the various applications of the electric motor for machine driving will find a capital set of illustrations of this kind of thing in a brochure of about 130 pages which has been brought out by the Westinghouse Companies. The work of arrangement, art illustrating, printing and so forth, is carried out in that excellent style which characterises this company's publications. The applications which are shown are some of those to which their motors have been put in the industries. As might be expected, they cover a very wide range, and indicate how electricity is making its way into practically every field where power is required. The type C polyphase induction motors (of 850 H.P.) are employed for operating the moving sidewalk at the Paris Exhibition, and other sizes are used at the shipbuilding yard of Harland & Wolff, at Belfast, at Burt, Marshall's bleaching works at Luncarty, and also at other places, as shown, for driving shafting, operating drilling, milling, and boring machines, hydraulic press, shearing and slotting machines, travelling cranes, mine hoists, pumps, elevators, and ore crushers, for operating paper machinery, and last, but not least, for operating lighting generators at the Buffalo and Niagara Falls electric light and power station at Niagara Falls. The Westinghouse direct current multipolar motors are illustrated operating travelling cranes, shears at steel works, repairing and other machinery in locomotive works, punches, pumps, and so on. Their direct current dust-proof motors operate stokers and a coal conveyor at the Manchester Corporation electricity works, also a plate planer at Hamilton, U.S.A., a 50-inch gun lathe, an electric charger for the Siemens furnaces and other purposes at the Parkgate Iron and Steel Works, near Liverpool, and they are also employed upon certain illustrated plants for pumping, crane, and various other operations.

Electrical Exhibits at the Agricultural Hall.—The Ironmongery and Hardware Trades Exhibition, which closes tomorrow, has afforded an opportunity for electrical firms who do business in art metal work to show what is being done to add to the beauty of home, as well as to improve the decorations of public buildings, by artistic electric light fittings. The half-a-dozen stalls at which electroliers, statuettes, standards, and so forth are shown, are the most attractive in the Exhibition. A striking display of French fittings is shown by Messrs. N. Burt & Co., of Oxford Street, who have been for many years agents for Coupier & Co., of Paris. Messrs. Burt exhibited various wall brackets and electroliers in the French styles, Renaissance, Louis XIV., XV. and XVI., and Empire periods, together with electrically-lighted clocks and candelabra, antique models from the French palaces of Fontainebleau, Versailles, Trianon, &c.; also marble pedestals, bronze and compo statuary figures mounted with branches, &c., and fitted for electric light. Messrs. Escaré & Denelle, Limited, of Wardour Street, are also there with French fittings in various styles, ornamental switch covers, electroliers, ceiling and wall fittings, examples of French chasing, and their well set out stand is made the more interesting by operations which are shown in progress. A very large exhibit by Jules Rolez, Limited, successors, of Paris, whose London chief office is at 68, Hatton Garden, comprises quite an elaborate showing of statuary, clocks and floral fittings with electric and gas lights, the charming variety of design and colour and the general arrangement compelling one to stay to inquire further.

Falk, Stadelman & Co.'s stand is made up of all kinds of fittings for all methods of illumination, the electrical comprising candelabra, brackets, and so forth. The great feature, however, is a grand electrolier suspended over the centre of the stand; it has many lights of various powers and a pleasing variety of shades.

The General Electric Company, Limited, is strongly in evidence with its thousand and one electric light fittings and accessories, with which nearly everyone is so familiar. A number of well arranged incandescent lamps with different coloured bulbs over-arching a bench at which Robertson lamp glass-blowing operations are carried out, make the exhibit stand out well among its fellows.

We must not omit to mention the combined stand of the Renewable Electric Lamp Company, Limited, and the British Electric Works Company, Limited, where again the interest of many visitors is being caught by the glass-blowing operation, also being conducted here. The Renewable Company show a number of their lamps in parts, illustrating the process of dealing with lamps which are sent to them for renewal. The company, we understand from Mr. Wray, the general manager, is doing a very large business at its Brunswick Place works in City Road, not only in renewable lamps, but also in the manufacture of ordinary incandescent lamps. The new two and four-arm shade adapters which have been recently brought out are to be seen at this stand. The manufactures of the British Electric Works Company, Limited, which are already familiar to our readers from the notices which have occasionally appeared in these columns, are shown, including the Stellite cam terminals, wall plugs, counterweights, high voltage ceiling roses, tumbler switches, and cut-outs. Messrs. Gent & Co., of Leicester, have a very full show of their well-known electric clocks, telephones, indicators, electric bells, water-level indicators and alarms, electric light fittings, also dynamos, motors, lamps, and other electrical apparatus. The electric cooling fans here furnish an additional attraction. Messrs. James Hinks and Son are present with their lamps and a number of electric light fittings. Mr. E. S. Hindley shows his engines, a dynamo, vertical boiler, and saw bench. The Harris Patent Feed Water Filter Company, Limited, shows one of its filters and other specialities. The Meyra Electric Company shows an assortment of their batteries of various sizes and for different purposes. Messrs. F. F. Braime & Co., Limited, of Leeds, are there with their seamless oil cans and other specialities; Lockerbie & Wilkinson, Limited, of Birmingham, are exhibiting their patent acetylene gas generators; and the Projectile Company, Limited, of Wandsworth, are showing tin stamping and metal working machinery driven by an electric motor.

The purpose of the exhibition and market, as it is termed, is to bring the trade into touch with buyers, and notwithstanding the summer weather and the absence of so many people from town, we hope that electrical exhibitors are now finding the show worth their while. On the occasion of our visit the consensus of electrical opinion did not point that way.

Fire Prevention.—With the close of the British Fire Prevention Committee's summer session, Mr. Edwin O. Sachs, as chairman, makes the following announcement regarding the fire tests carried out under the auspices of that body, which will give some idea of the amount of work done in the form of investigations, quite irrespective of the general duties of the Committee. Since the Committee's incorporation—*i.e.*, during a period of 18 months—there have been 12 tests with fire-resisting floors, and two with ceilings, and there have been nine tests with fire-resisting partitions. There have been no less than 23 tests with different forms of wood and iron doors, and eight with various forms of glazing. Besides this, there have been several odd tests with treated wood, with fire curtains, fire blinds, girder coverings, and safes. Altogether, the tests number 63. The reports on these 63 tests are embodied in 44 publications, many of which are extensively illustrated. The Committee has met with the ill-fortune of having to move its plant to new premises, owing to the site on which they are now located at Regent's Park being taken up for railway purposes.

Journalistic.—Two of our exchanges have thrown in their lot together, and in the bonds of newspaper wedlock, they have just made their bow to the public as the "*Hardware Trade Journal*, with which is incorporated *Ironmongery*." The *Hardware Trade Journal* has bought *Ironmongery* over from Messrs. Collingridge. The new production, which is owned by the Hardware Trades Journal, Limited, is edited by Mr. Frederick J. Francis, and will appear monthly as hitherto.

Julius Sax & Co., Limited.—We have received from this company a copy of their new catalogue of English electric bell material. Considering that the firm of Julius Sax has been in existence since 1855, and has had an experience in this particular branch of the trade which is unique, one is not surprised to find in this publication one of the most complete descriptive catalogues of the kind published. We may also add that it is well got up in every way. Many of the patterns are novel, and the designs protected by patent or registration. A good feature of the list is that a distinction is made where material is used not of the firm's own make, and all goods sold as "English made" are guaranteed of English manufacture throughout. The managing director, Mr. H. M. Salmony, asks us to point out that he is no longer connected with a company formed by him and still bearing his name, and also that Julius Sax & Co., Limited, of Coldharbour Lane, S.E., is the original and parent firm, having no connection with any other concern using that name. We understand that the company has been busy lately with work for the Government and certain local authorities, and has executed orders for the supply of electric bells and accessories to the Post Office, War Office, and Admiralty. Although staking its reputation more particularly upon the highest quality goods, the company, in order to meet demands for cheaper lines, has laid down improved machinery for producing articles to compete with those of foreign make. Amongst other things, the catalogue has descriptions of improved indicator movements, of which the electrical replacement movement is specially worthy of notice. Many other things might be mentioned, but we would advise those interested to apply for a copy of the book itself.

Liquidations and Dissolutions.—The British Blahnik Arc Light Company, Limited, is winding up voluntarily, with Mr. W. H. Chantrey, 57, Moorgate Street, as liquidator.

Messrs. J. H. Blake and H. E. Steel (Blake & Steel, electrical engineers, Cheltenham, Gloucester, and Stroud) have dissolved partnership. Mr. H. E. Steel attends to debts.

New Company.—Offices have been opened in London by Messrs. J. G. White & Co., Limited, electrical, mechanical and civil engineers, a new company which has been organised by the firm which bearing a similar title, has carried on a very extensive electrical engineering business in the United States for some time past. The London Company, which has a nominal capital of £100,000, will take over and execute all the firm's business outside North America, and London has naturally been considered the right place for the proper conduct of this foreign trade. The names of the directors are given as follows:—

Chairman, J. G. White, A.M., Ph.D., Mem.A.I.E.E., President of J. G. White and Co., of New York.
Managing Director, O. H. Baldwin, M.E., Mem.A.I.M.E., recently managing director of Westinghouse Electric Company, Limited, London.
Chief Engineer, A. N. Connett, C.E., Mem.A.S.C.E, recently chief engineer of Compagnie Francaise Thomson-Houston, Paris, France.
E. B. Wyman, director, Deep Leads Electric Transmission Company, &c.
Electrical Engineer, W. C. Burton, E.E., Mem.A.I.E.E.
Secretary, A. H. Beatty.

The offices of the company are at 22A, College Hill, Cannon Street, E.C. The U.S. White Company have carried out the equipment of many miles of electric road, as well as large electric light and power installations, in America. Mr. White has acted as consulting engineer for many schemes, including the complete designing and erection of the Niagara Power Company's transmission line, and in regard to foreign work now under way, the company is identified in some way or other with various electrical engineering plants for Australia, San Juan, Porto Rico, and so on. The company has set out over here with the intention to develop a big business, and with so much work now waking up, its hopes should not remain unrealised for long. Messrs. White will be prepared to act as inclusive

contractors for the complete design and construction of all types of electric tramways and railways, electric power and lighting plants, and all similar undertakings, and to assist in financing commendable projects. They are also prepared to make examinations of operating plants, report upon their physical condition and management, and to supervise the operation of such plants; also to make reports by competent and experienced engineers for bankers and investors on both engineering and financial features of projected or operating enterprises in any part of the world. The members of the executive and engineering staffs have had extensive experience in financing, designing, building under contract, and operating electrical properties.

Paris Exhibition Awards.—At their stand at the Paris Exhibition the Blackman Ventilating Company, Limited, show their well-known fans, two of them in motion, each driven by, and combined with, a special electric motor of the company's manufacture. These two fans are 36 inches in diameter; one of them exhausts air from, and the other blows air into spaces open to the visitor; these spaces are easily separable, or made common at pleasure, by a door, so that the effect of the fan for either purpose is seen and felt at a moment's notice. A number of the company's belt or rope-driven fans are also shown, as used for ventilating and drying purposes. We understand that more than 50,000 Blackman fans have been put to work in all parts of the civilised world, displacing more than a million tons of air per hour, whilst Blackman electric fans are to be found in thousands, ventilating not only workshops and factories, but the apartments of Royalty, the Houses of Legislature, banks, clubs, hotels and so on. Blackman fans are very largely used on ocean-going steamers, and there is scarcely a foreign port at which these fans are not to be found doing useful work, such as withering tea leaf in India, China and South Africa, drying cocoa and coffee in the East and West Indies, ventilating mills in all countries from South America to Japan, and drying wool, yarns, textile materials, &c. A gold medal has been awarded to the company for their exhibit at the Paris show.

The Simplex Steel Conduit Company, Limited, inform us that they have been awarded a gold medal at the Paris Exhibition, Class 25, for electric lighting; in addition to which their engineer and general manager, Mr. L. M. Waterhouse, A.M.Inst.C.E., and their works manager, Mr. L. H. Lander, A.I.E.E., have been awarded silver medals.

The Electrical Power Storage Company and the Chloride Electrical Storage Syndicate, Limited, have received gold medals in Class 24, Electro-Chemistry.

Among the names of prize-winners we notice those of Messrs. C. A. Parsons & Co., and the Parsons Marine Steam Turbine Company, Limited, as having between them carried off two Grands Prix and two Gold Medals. Messrs. C. A. Parsons & Co. obtained the Grand Prix in Class 19 for "Steam Engines," and Gold Medal in Class 23 for "Mechanical Production and Utilisation of Electricity." The Parsons Marine Steam Turbine Company, Limited, obtained the Grand Prix in Class 33 for "Materials and Plant used in the Mercantile Marine," and Gold Medal in Class 118 for "Naval Construction." This speaks well for the various exhibits of the above firms.

The official list of awards in connection with the Paris Exhibition contains intimation of the following successes in Group 5, "Electricity":—

Class 23.—Production and Mechanical Utilisation of Electricity.

Grand Prix: Siemens Bros. & Co., Limited.
Médailles d'Or: C. A. Parsons & Co.; Mather & Platt, Limited.
Médailles d'Argent: Robey & Co., Limited.
Médailles de Bronze: Belshaw & Co.
Collaborateur: Grand Prix. Dr. Edward Hopkinson (Mather & Platt, Limited).

Class 24.—Electro Chemistry.

Médailles d'Or: Electrical Power Storage Company; Chloride Electrical Storage Syndicate.
Médaille d'Argent: Sherard Cowper-Coles.
Collaborateurs: Medaille d'Argent. Herbert Butler (E. P. S. Company).

Class 25.—Electric Lighting.

Médailles d'Or: Benson & Co. and the Simplex Steel Conduit Company.
Médailles d'Argent: Belshaw & Co. and the City of Bath.
Collaborateur: Médaille d'Argent. Mr. Lander and Mr. Waterhouse (Simplex Steel Conduit Company).

Class 26.—Telegraphy and Telephony.

Grand Prix: British Post Office.
Médailless d'Argent: Patent Nut and Bolt Company.

Class 27.—Applications of Electricity.

Grand Prix: White.
Médaille d'Or: Crompton & Co.
Médailles d'Argent: James Hicks; Stockall & Sons.
Collaborateur: Médaille d'Argent. Mr. Wm. Burton (James Hicks).

The jury have awarded to Galloways, Limited, of Manchester, the Grand Prix, the highest possible award, for the exhibit consisting of six steel Galloway boilers, capable of supplying steam for 3,500 I.H.P. and working at 160 lbs. pressure, and one Galloway vertical compound engine and dynamo capable of an output of 1,600 amperes of 250 volts. This is the third occasion upon which Galloways have received the Grand Prix at Paris, having been awarded this distinction at the Exhibitions of 1878 and 1889.

Smoke Nuisance.—The South London Electric Supply Corporation has been fined £10 and costs on a summons by the Lambeth Vestry for allowing a black smoke nuisance at their works.

Spain.—La Maguinista Bilbaina is the title of a new concern which has just started works at Deusk, near Bilbao, Spain, for the construction of electrical plant.

The Rubber Industry.—The *Board of Trade Journal* says that the Board of Trade have received through the Foreign Office copy of despatch, dated 4th inst., from H.M. Ambassador at Berlin, enclosing copy and translation of a decree of the German Government, relative to the protection of the rubber industry in German East Africa. By this decree, which came into force on January 1st, 1898, the preparation of impure rubber and the habitual purchase and sale of the same is rendered punishable by a heavy fine. The above decree may be consulted on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament Street, S.W., any day between the hours of 10 a.m. and 5 p.m.

Tramways for Sale.—This heading does not refer to portable models for lectures or toy purposes, but to the valuable electric cable and horse tramway undertakings of the Isle of Man Tramways and Electric Power Company, Limited (in liquidation). For further particulars of the announcement see our "Official Notices" to-day.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—For the lighting last year the estimated expenditure was £9,990, and the actual £9,650. For the current year the expenditure is estimated at £11,800, the increase being due to the proposed substitution of the electric light for gas in the central parts of the city for street lighting.

The Gas and Electric Lighting Committee last week resolved upon a site for the erection of the proposed new electric lighting station.

Abertillery.—The District Council has decided to take steps to obtain a provisional electric lighting order. A sub-committee will visit various towns where public abattoirs and dust destructors are in operation.

Ballymena.—An electric light scheme has been drawn up by a Mr. M'Carthy, an electrical engineer (cost £8,000), and it is to be considered by a committee of the Urban District Council.

Battersea.—The foundation stone was laid on Saturday of the new generating station from which the parish of Battersea will be supplied with electric light. The chief point in the speech of the chairman of the Lighting Committee (Mr. W. Willis) was that all the work had been carried out without the intervention of a contractor. The work of laying the mains was started in February of the present year, and it was expected that by April or May next the parish would be completely equipped, with the additional advantage that the working man would be placed in a position to enjoy the new illuminant on the system which was known as that of "the penny in the slot." The stone was laid by Mr. W. Matthews.

Blackburn.—On 17th inst. a Local Government Board inquiry was held into an application of the Corporation to borrow £190,000 for electric lighting and power extension purposes. The present scheme will carry the Corporation on for four or five years, when they will still have land available at their proposed new works for an even bigger scheme.

Blackrock.—There is a proposal on foot that the two Urban District Councils of Kingstown and Blackrock shall undertake a joint scheme for electric lighting.

Bohemia.—A central electric lighting station is about to be established in the town of Elbogen, on behalf of the municipal authorities. Water-power is to be utilised.

Bo'ness.—The North British Supply Company and the South Shields Electricity Supply Company are negotiating with the Burgh Commission with a view to electric light proposals.

Bradford.—Last week the City Council appointed the chairman and the deputy-chairman of the Electricity Committee to arrange with a local firm of architects for the preparation of plant for a new generating station at the Valley Road electricity works.

Brisbane.—The Municipal Council has been engaged upon the consideration of electric lighting proposals submitted by several parties, including Messrs. Wright and Reason, the Electric Construction Company of Australasia, and others. The proposals and terms offered were reported upon by Mr. John Hesketh, the Queensland Government electrical engineer. The Council held a long discussion on June 16th, covering the whole question, and ultimately the matter was referred to a committee.

Buenos Aires.—One of the troubles under which the River Plate electrical industry labours to-day is stated in the following paragraph from the *Review of the River Plate*:—"The electric light companies in the city of Buenos Aires have entered a joint protest against the taxation imposed this year by the Municipality, and which they consider to be a duplicate of another tax. The companies have to pay 5 per cent. of their gross receipts for the use of the subsoil, and this year a tax has been placed on all transformer pits and corner boxes, and this the companies consider to be already covered by the 5 per cent. tax. We understand that the companies intend to test the legality of several other taxes amongst them and that of the 5 per cent., because when some of them obtained their concessions the tax was only 2½ of the gross revenue, and if the authorities have the right to increase it to 5 per cent., they would have an equal right to make 10, 20, or, in fact, any rate they choose."

(Continued on page 307.)

SUNDERLAND ELECTRIC TRAMWAYS.

An instalment of the tramway scheme drawn up for the Corporation of Sunderland by their electrical engineer, Mr. J. F. C. Snell, was examined by the inspectors of the Board of Trade and Local Government on the 15th inst., and forthwith opened for traffic. The new electrical section extends from the centre of the town in three directions, and comprises a total length of 15 miles of single track. Electric power for operating the line is obtained at present from the Corporation electricity works; as we recently stated, a new power station, for lighting and traction combined, is to be erected at once. Meanwhile, a short account of the work already accomplished may be of interest.

stipulated that the special work at the crossings should be carried out without interference with the traffic on the railways. This was successfully accomplished by the contractors, Messrs. Dick, Kerr & Co., who laid the permanent way: this firm, it should be mentioned, obtained the contracts for carrying out the whole of the work in connection with the electric tramways.

While the track was being built, provision was made for the feeders by laying a four-way stoneware casing in the road bed, with brick street boxes at intervals of 40 yards.

The feeders are all of Messrs. Callender's lead-covered paper-insulated type, drawn into the ducts above-mentioned; it was specified that they should have an insulation resistance of not less than 500 megohms per mile when tested at 500 volts after immersion in water, and should withstand a pressure test of 10,000 volts alternating after repeated bending and immersion in water. The feeders were

Sunderland Electric Tramways.

The foundation of the tramways consists of a bed of concrete, 6 inches thick; upon this the rails, 7 inches deep, and weighing 96 lbs. per yard, are laid. The joints in the rails are made with fish plates 24 inches long, together with sole plates, 30 inches long × 12 inches × $\frac{5}{8}$ inch, bolted to the under surface of the flanges: the gauge is 4 feet 8½ inches. Each joint is bonded with two copper Chicago bonds, and the rails and tracks are cross-bonded at intervals of 120 feet with similar bonds. All the points are of cast-steel, of the spring type, and were supplied by Messrs. Askham Bros. & Wilson; the crossings were built up of rails similar to the track rails, and drain rails were provided where required. One of our illustrations shows the special work at Southurch Road.

During the progress of the work, which involved the conversion of existing tramways, cross-overs were laid so as to enable traffic to be carried on with horse cars without interruption. A somewhat unusual feature in tramway work in this country consists of level crossings over steam railways: these were rendered necessary at Sunderland by the prior existence of private railways, or, as they are called locally, "wagon-ways," leading to adjacent collieries, and it was

designed to give a distribution efficiency of 95 per cent. with 50 cars running: they vary in size from 0·35 square inch to 0·1 square inch cross-section, and were laid along the routes shown on the skeleton plan herewith. In addition to the positive feeders, two negative feeders were laid to the points shown on the plan, each 0·25 square inch in cross-section, and were connected with boosters in the electricity works. Three-core pilot and telephone cables were also laid from the works to five points on the system.

The feeder pillars are situated at half-mile intervals, and are fitted each with two 400-ampere, and four 100-ampere quick-break switches, testing terminals, and lightning arrester, mounted on marble panels.

The overhead gear comprises centre-pole, side bracket, span wire, and rosette suspension, the first two of which are shown in our illustrations. The poles used are built up in two sections, telescoped for 18 inches, and welded together. They are 31 feet long, and stand 25 feet above ground. Three sizes of pole are in use, specified to give a temporary deflection of not more than 6 inches and a permanent set of ½ inch, with the following test weights applied near the end:—

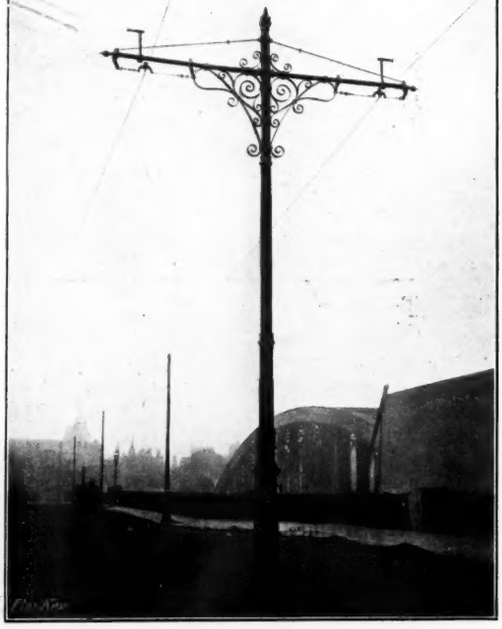
No. 1, for temporary deflection test, 500 lbs.; for permanent set test, 1,000 lbs.; No. 2, 900 and 1,500 lbs.; No. 3, 1,200 and 2,000 lbs. In addition the poles had to pass drop tests and dimensional tests.

The trolley wire is of hard-drawn copper, 0·325 inch diameter, and capable of withstanding a tensile stress of 4,400 lbs.

The whole of the overhead electrical equipment, switch pillars, &c., was supplied and erected by the British Thomson-Houston Company as sub-contractors.

Sunderland Electric Tramways.

The negative boosters are motor driven, each capable of carrying a current of 250 amperes with a "boost" of 30 volts, and are compound wound. Normally the series field winding alone is in use, in series with the positive feeder, as usual, the armature being in series with the negative feeder; but a fine wire winding is provided suitable for separate excitation from the 500-volt mains, for use in case of a breakdown in the positive feeder. Under these conditions the amount of boost is regulated by a hand rheostat in the field circuit.



Sunderland Electric Tramways.

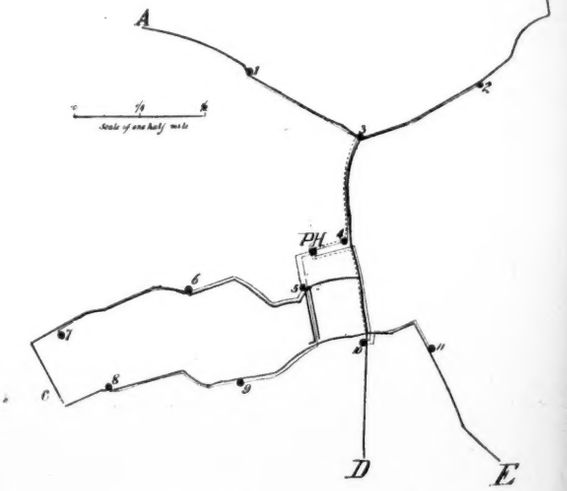
It is intended that not only shall the Board of Trade regulations be complied with, but the drop in the rails shall not exceed 3½ volts when all the cars are running.

Most of the cars are of the Electric Railway and Tramway Carriage Works Company's standard "Liverpool" type, with reversed stairway, as shown in one of our illustrations. There are 12 double-deckers, to seat 46 passengers; six double-deckers, with maximum traction bogies, to seat 60; and eight of the single-deck type, to seat 26. The last are divided into compartments for smokers and non-smokers.

The trolley is of the side swivelling type, fixed in the centre of the car. The electrical equipment of the cars is of the English Electric Manufacturing Company's make. The motors are designed to give a tractive effort of not less than 1,000 lbs. at the rim of a 30-inch wheel, at a speed of 10 miles per hour, or to give 25 B.H.P. continuously; the gear ratio is 4½ to 1. The motors were required to pass a test of 2,000 volts alternating, applied for one hour, between motor circuit and frame, and a pressure of 1,000 volts in the same way at the end of a day's run any time within the first twelve months of running.

The controllers are of the series parallel type, with magnetic blow-out, and are provided with an emergency electric braking stop.

The whole of the work has been carried out in the very best style, and has given great satisfaction. Considerable additions to the present system are to be made, and when the scheme is complete, the Sunderland tramways will form one of the most important and comprehensive systems in the country. We have to congratulate the electrical engineer, Mr. Snell, and the contractors, on the excellent progress which has already been made towards this end.



Routes B—D, Roker and Christchurch.
A—3, Southwick.
E—10, Tatham Street.
5—10, *via c*, Chister Road.
P H, Power house.
● Feeder boxes.
——— + Feeders.
- - - - - Return feeders.

Sunderland Electric Tramways.

THE METROPOLITAN RAILWAY, PARIS.

The history of the schemes, which had been proposed at various times during the past 45 years, for a convenient suburban traction service in Paris, is very interesting. It shows perfectly what wonderful effects and what changes in ideas have been the result of successful electrical traction.

Lyon Station.

There were constant discussions and dissensions as to whether an overhead or an underground system should be adopted. In the early days when steam driving was the only means at hand to serve the purpose, the advocates of the overhead line were in the majority; naturally they did not wish to travel in underground tunnels, where smoke, steam, and other foul vapours were present.

Of late years, however, the advocates of an underground system for Paris have been in the majority, since the objections just mentioned have been entirely removed by the successful introduction of electrical traction.

Eventually it was decided to instal an underground system of electrical traction. When completed there will be about 26 miles of track, of which $8\frac{3}{4}$ miles were opened to the public and commenced operation on July 19th of this year. The part in operation consists of about 6 miles length between La Porte de Vincennes and Porte Maillot, and two short branches, viz., from Porte Dauphine to Place de l'Etoile and from the Trocadero to Place de l'Etoile.

The whole of the line is double tracked, with the exception of some very short single track loops at junctions and at terminal stations.

Lyon Station.

The subterranean tunnel of the double track has an elliptic vault about 23 feet wide, 7 feet high, and 1·7 feet thick; the vertical sides are 2·5 feet thick and 9·5 feet high: the floor is of the shape of a reversed vault, and is 1·5 feet thick, the deepest point of floor surface being 2·3 feet below the rail head.

The interior of the tunnel is lined with a thickness of 0·76 inch of Wassy cement on the vault, and a similar coating of Portland cement lines the walls and the floor.

On curves with a radius of less than 328 feet, the width of the tunnel is increased. With curves of 300 feet radius, the width of the tunnel is 24 feet; with curves of 160 feet radius, the width is 25 feet approximately.

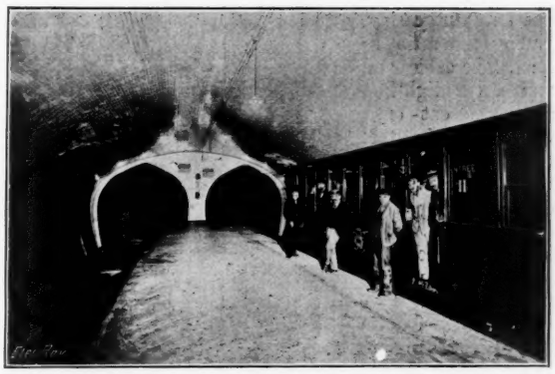
The single track tunnel has a vault of semi-circular shape, of about 7 feet radius and 1·5 feet thick. The height of the side walls is 8·3 feet, and their thickness is nearly 2 feet; the sides are 14 feet apart at the floor, which is slightly convex, and has a thickness varying from 1·55 feet at the centre to slightly less at the sides. This tunnel at the curves of less than 100 feet is constructed rather wider at the base.

The rail track is laid on cross sleepers of creosoted wood, spaced about 3 feet apart in ballast varying in depth from about 2 feet to 0·6 feet.

The track gauge is 4·4 feet, and the rails are of the Vignoles type, 100 lbs. per yard, in lengths of about 50 feet. The rails rest on flat plates or chairs, the lengths being joined by four-hole fishplates about 2 feet long.

The track is electrically equipped on the third-rail system, with track rail returns. The main rail is supported on porcelain insulators, set on extensions of every second or third track rail sleeper, according to the position of the rail joints. The conducting rail is similar to the track rails, and all joints are bonded with four copper bonds.

The stations on the parts which are in actual operation are 25 in number. The line from La Porte de Vincennes to Porte Maillot has 18 stations, the branch line from Place de l'Etoile to Porte Dauphine has three, and the branch



Station at Port de Vincennes.

from Place de l'Etoile to the Trocadero has four stations. This includes as separate stations the three distinct parts at Place de l'Etoile.

Of these stations, 17 have a vaulted roof, and are of similar construction to the tunnels, with an additional lining of glazed tiles and bricks.

Seven stations have steel girder roofs, with intermediate masonry arches, and one station alone, the Place de la Bastille, is open to the sky.

The passenger platforms are 13 feet wide, and rather more than 3 feet high above the rail-head; by this arrangement passengers step down about 5 inches into the railway train when embarking. Staircases lead from the street pavements down to the station platforms. Both the trains and the tunnels are electrically lighted; the stations with vaulted roofs are lighted by incandescent lamps, spaced about 13 feet apart, and those with the steel girder roofs are lighted by arc lamps.

The rolling stock consists of trains made up of one locomotive and two trailers. There are 46 locomotives or motor carriages; of these 34 are provided with a controller at one end only, and 12 have a controller at each end. The horse-shoe arrangement of the track at each terminus obviates the necessity of running the trains in both directions, and turntables are provided should it become necessary to turn the locomotive.

Each locomotive is equipped with two Westinghouse motors. They are of 120 H.P. each, four-pole, and are

entirely iron-clad. The pole-pieces are of soft steel laminations, cast into the iron sheathing or shell.

These motors were supplied under very stringent conditions as to their reliability and capacity for work under considerable overloads for long lengths of time. They were first put under the actual tests stipulated, and in every case came up to their guarantee perfectly. They stood an overload for some time of 100 per cent., a pressure of 3,000 volts alternating current on their coils, and a pressure of 500 volts between adjacent commutator bars. The motors run on a 500-volt circuit when operating the railway.

The motors drive through a single reduction spur gearing, having the ratio as 1 : 2. The cables and mains, car lighting, automatic cut-outs, fuses, and in fact the whole of the electrical equipment of the rolling stock and track is Westinghouse, including the series-parallel controllers, which are of the well-known magnetic blow-out type. The total weight of a train, one locomotive and two trailers, with their full complement of passengers, is about 70,000 lbs.

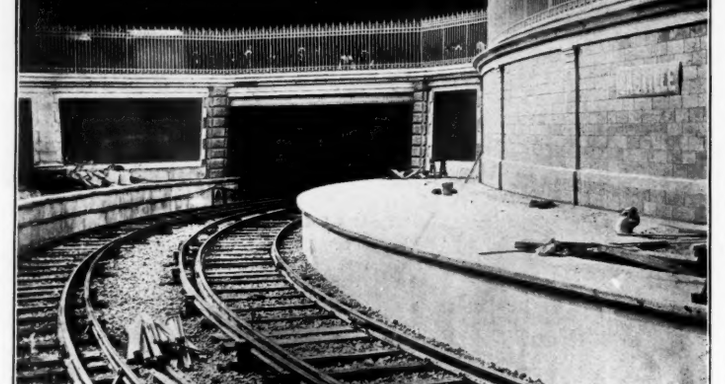
The generating station is situated at Bercy on the Quai de la Rapée.

The boilers are of the semi-tubular type, and are arranged in three groups of six each. The two engines are of 2,600 H.P. each, and run at 70 revolutions per minute. They are direct coupled to the generators, of which there are both alternate and direct current sets. The alternate current dynamo is three-phase, and yields an output of 1,500 KW. at 5,000 volts pressure, and at a frequency of 25 per second. The direct current machine yields 1,500 KW. at a pressure of 600 volts. There is, of course, a full equipment of exciters, boosters, converters, switching devices, and also a storage battery. The three-phase current is supplied to a converter sub-station at Place de l'Etoile, and is changed to direct current at 600 volts to feed that part of the line. This sub-station is very fully equipped, and contains the following apparatus : — Nine transformers of 250 KW. each, changing the three-phase current pressure from 5,000 volts to 360 volts, three converters of 750 KW. each, a battery of accumulators of 1,800 ampere-hours' capacity, two boosters of 250 KW., and switchboard arrangements. Two sets of three-phase feeders enter this station and three direct current feeders leave it.

The fares charged on this line are 25 centimes for first-class, and 15 centimes for second-class passengers, whatever the distance travelled may be.

The trains are now in full operation. The comfort of travelling, and the speedy means of getting from one part of the city to another without bother, crush, or hurry on the part of the passengers has already made the line immensely popular, and ensured a prosperous future for this railway, for which Paris has waited so long.

The only Open Air Station, Place de la Bastille.



Station at the Champs Elysees.

View of Carriage.

Sturtevant Engineering Company.—This company is circulating, for the benefit of electrical engineers visiting the Paris Exhibition, a list of exhibits at which may be seen machines of many varieties being driven by motors controlled by their Cutler-Hammer motor controlling apparatus, for which they invite an inspection.

ELECTRIC LIGHT AND POWER NOTES.

(*Continued from page* 302.)

Carlisle.—The Public Lighting Committee have decided to fix two 32-c.p. incandescent lights on arc lamp pillars in the public streets, and to light them after 11 p.m., in place of the arc lamps. The change is to be made on one circuit of 10 arc lamps, first, as a trial.

Crieff.—In connection with the proposal of the North British Electric Supply Company to apply for a provisional order, the Council has appointed a committee to consider whether the matter shall be kept in its own hands.

Driffield.—A Hull paper says that several firms of electrical engineers have communicated with the authorities at Driffield offering their professional services to the town. They had heard that arrangements were being made for supplying the town with electricity. The writer adds: "Evidently the wish was father to the thought, as the Council have never so much as contemplated anything of the sort. At present they have enough on their hands withthe gas light undertaking."

Dublin.—The meeting of the Electric Lighting Committee held on 17th inst., had before it the consideration of the report of Messrs. McCall and Jones, who were recently appointed as a sub-committee to visit Continental cities with the object of inquiring into the working of the three-phase system of electric lighting there, with a view to reporting as to the advisability, or otherwise, of adopting that system for the purposes of electric lighting in Dublin. The sub-committee's report was read, and the substance of it was that they recommended the adoption of the three-phase system for the electric lighting of the city. The Electric Lighting Committee ordered that the report should be printed and circulated amongst the members of the Corporation, and its contents will be discussed at the next monthly meeting of the Council.

The *Daily Nation* for 18th inst. says the Lord Mayor has called a special meeting of the Corporation for Monday, for the purpose of adopting a report of the Electric Lighting Committee. The report in question is dated June 13th, and contains the following statement:—

After full consideration of Mr. Hammond's reports, your committee beg to submit for the acceptance of the Municipal Council the recommendations following:—

1. That the tender of the General Electric Company, Limited, London, for compound engines, generators, &c., be accepted for the sum of £33,061;
2. That the tender of Messrs. Holdsworth & Sons, Bradford, for Lancashire boilers, be accepted for the sum of £6,653;
3. That the tender of Messrs. Babcock & Wilcox, Limited, London, for water-tube boilers, be accepted for the sum of £5,278;
4. That the tender of Messrs. Holdsworth & Sons, Bradford, for fuel economisers, be accepted for the sum of £1,060; and
5. That the Town Clerk and Law Agent be authorised to take any steps that may be necessary in connection with the carrying out of the foregoing recommendations.

Farnworth.—The buildings at the electricity works are progressing very rapidly, and the consulting engineers, Messrs. Lacey, Clirehugh & Sillar, hope to be able, within a very short time, to instruct the contractors to commence erecting the plant.

Friern Barnet.—The Urban District Council is applying for a provisional order.

Hexham.—The District Council will receive representatives of the Northern Counties Electricity Supply Company at its next meeting.

Hunstanton.—The Urban District Council has resolved to apply for a provisional order.

Idle.—The Northern Counties Electricity Supply Company (Newcastle) has decided not to proceed further in the matter of the proposed supply to Idle now that that township has been taken into the City of Bradford.

Knutsford.—The Knutsford Urban District Council have found their provisional order for electric lighting something of a "white elephant." At the last meeting the Lighting Committee recommended an application to the Board of Trade for an extension of time to permit of further inquiries, but an amendment was carried by which the clerk was instructed to ascertain the terms upon which any company or companies were prepared to take over the provisional order from the Council.

Lancaster.—The Local Government Board has sanctioned a £20,000 loan for electric lighting.

Leigh.—The Town Council at their last meeting increased the salary of Mr. John Foster, gas, water and electricity engineer, from £300 to £400 per annum. The Council proposes to hire out motors and to supply power at cheap rates.

London.—At the City of London Union last week the Finance Committee submitted the specification of Mr. Collins, of 62, Broad Street, for the electric installation and ventilation at the Board offices. The specification was for £533 10s., £250 of which was for the installation. The matter was referred back.

London.—Shoreditch.—The Vestry on Tuesday resolved to take up a loan of £42,400 from the London County Council, and at the same time referred to the Finance Committee for consideration the question of the refusal of the County Council to advance £25,000 owing to the lack of sufficient information. On the recommendation of the Lighting Committee, the Vestry approved the following rules for dealing with the accounts of consumers for current supplied:—

Weekly Accounts.—Meters to be read, as at present, each Thursday, and demand notes sent to the accountant's office the same day. Payment to be made by the Friday week following, failing which the collector is to attend at the lighting station, Coronet Street, and proceed to the defaulter's premises, together with a representative of the electrical engineer, who will disconnect the supply unless payment is made on demand.

Monthly Accounts.—Meters to be read on the last day of each month, and demand notes to be sent to the accountant's office the same day. On the demand notes payment is requested within 15 days, but the consumers should be allowed credit to the 21st of each month. If payment is not made by that date, final notice allowing three days' grace to be served, at expiration of which time the collector, accompanied by a representative of the electrical engineer, is to call at the defaulter's premises, and in default of payment the supply is to be cut off.

Quarterly Accounts.—Meters to be read as near quarter day as possible. Demand notes to be sent to the accountant's office by the 15th of the next month. Payment is requested within 15 days on demand notes. In the first week of the last month of the quarter a list of outstanding accounts is to be prepared at the lighting station, and defaulters on this list who have not paid by the Friday, 14 days before quarter day, are to be served with final notice giving three days' grace, after which the supply will be disconnected in the same way as monthly accounts.

When the supply has been disconnected under these rules all expenses of re-connection shall be charged to consumer. In order that consumer's accounts shall be kept posted, the accountant will supply a weekly return of all cash received on electric lighting accounts every Friday. In addition to the "second notice," it is suggested that the "final notice" allowing three days' grace before cutting off the supply "without further notice," should be served by the rate collectors in the name of the Vestry clerk, as the legal representative of the Vestry.

Loughton.—A conference of representatives of Loughton, Woodford, Buckhurst Hill and Wanstead, has been held relating to the subject of electric lighting.

Maidstone.—The Local Government Board have notified that while they are virtually prepared to approve the scheme of electric lighting for the borough, they would like to have the opinion of an independent expert with regard to the same. The matter having been considered by the Council in committee, it has been suggested that Sir William Preece should be asked to give his opinion.

Rathmines.—To-day, at 3 p.m., the Council's electricity works were to have been formally opened by the Lord-Lieutenant, but owing to indisposition of Lord Cadogan, the ceremony has been postponed to August 31st.

Rhyl.—The Council has secured permission to borrow £15,250 for electric lighting, and £6,750 for refuse destructor.

Rochdale.—Messrs. Lacey, Clirehugh & Sillar hope to commence the official tests of the plant this week.

Slaithwaite.—The Northern Counties Electrical Supply Company have informed the Slaithwaite Urban District Council of their intention to apply for an electric lighting provisional order. The Council, which owns the gasworks, has decided to interview the company.

Stirling.—The staff at the electricity works is to be increased. The plant is to be extended to meet the increased demand, as fully two-thirds of the present output has been applied for. The Electric Lighting Committee is to draw up a report with reference to an extension of the power station in order that there be no unnecessary delay in delivering the machinery. The present state of the engineering trade is used as an argument for immediately settling what is to be done.

Taunton.—The Corporation Electric Light Works were on Wednesday last week the scene of two very interesting ceremonies. The first of these, which was performed by the Mayoress, Mrs. W. A. Wrenn, consisted of the switching on of the new machinery which has just been erected at a cost of £5,000, and the second was the presentation to Alderman W. Potter, chairman of the Electric Lighting Committee, of an illuminated scroll, and to his wife, of a handsome silver tea service, with a large silver tray. Before the Mayoress switched on the new machinery, Alderman Potter made an explanatory statement. The presentation was made by the Mayor, Councillor W. A. Wrenn, who explained that it was in recognition of the strenuous and successful efforts Mr. Potter had put forth to convert the works into a paying concern. When the Corporation took over the works, it was necessary for several years to make a heavy call upon the rates to meet the working expenses, but last year, after paying expenses, interest and sinking fund, the committee were able to hand over £300 for the relief of the rates. The gifts were subscribed for by the members of the Council and townspeople generally, and Alderman Potter, in acknowledging them, remarked that the success of the works, considering the size of the town, had been unique.

Willenhall.—At a meeting of the Urban District Council on Monday, the clerk intimated that he had that day had an interview with the representative of the Electric Corporation for Power Distribution, who had stated that the Corporation intended to commence at once the laying down of electric mains. These are to supply private and public consumers with electricity for lighting and for motive power. The work, it was stated, will be completed by the end of next February.

Wimbledon.—These electricity works were opened by the municipality on June 17th last year. The plant was put down for supplying the equivalent of 5,000 8-c.p. lamps for street lighting and 5,000 for private lighting. When the works

opened a few hundred lights were connected and 8,415 applied for. At the present time, however, this has increased to 19,000 lamps applied for for private lighting alone. Between 300 and 400 consumers are on the books, and the average number of lamps applied for per month has been 900 8-c.p. This has necessitated the preparation of an extension scheme by Mr. F. Barnes Spencer, the resident electrical engineer. The scheme has been approved by the Council, and is to be carried out by Mr. Spencer, the expenditure being about £18,000. The usual public inquiry *re* loan is shortly to be held.

Windsor.—The Windsor and Eton Electrical Installation Company have just completed the erection of a new battery room at their central station in Peascod Street, which will be capable of supplying 1,600 8-c.p. lights for 10 hours.

Yeadon.—The District Council has had a conference with Mr. W. C. C. Hawtayne, who is at present superintending the carrying out of electric lighting works at Heckmondwike. At the close of the conference the Council resolved to take a *plébiscite* of the householders in the compulsory area of supply, for the purpose of ascertaining the number of lights likely to be taken up at a charge of 5d. per unit, and after that to submit the whole of the facts to a ratepayers' meeting. The period of grace allowed by the Board of Trade before proceeding to consider the revocation of the Council's provisional order expires in a little over two months.

York.—A scheme and estimate for electric lighting of the laundry is being drawn up by the architect to the Board of Guardians.

ELECTRIC TRACTION NOTES.

Aberdeen.—The Corporation tramway accounts for the past year embody the results of the first complete year of the electric haulage system. The new method has, of course, effected a substantial saving. The average revenue per mile by horse traction was 11·06d.; by electric traction, 10·56d. The working expenses were at the rate of 8·31d. for horse traction; for electric traction, 6·39d. The revenue amounted to £31,557 0s. 9d., and the working expenses to £23,027. There thus remains for interest, depreciation, sinking fund, &c., the sum of £8,529 13s. 11d., of which £2,689 had been carried to renewal accouut.

Ayr.—The Town Council have abandoned the proposal to supply electric power for the tramways from an independent generating station, and have agreed to accept an offer from the Electric Light Committee to supply the current from the existing electric stations at 1½d. per unit for the first 200,000 units, and 1d. per unit for any quantity above that.

Brighton.—At the last Council meeting there was a protracted discussion on the scheme for developing the Aquarium. The committee, who recommended that competitive designs should be invited, were of opinion that the architects should be permitted to provide for the construction of an electrical tramway over the site from the west end of the Aquarium to the east end of the covered terrace at Kemp Town. It was argued that such a line would have the effect of removing a great eyesore and obstruction to the beach. There was no desire, it was stated, to interfere with Mr. Volk's electric railway, but, on the contrary, it was desired that he should share in the benefit of the new line. On the other side, it was pointed out that the Council had given Mr. Volk a long lease, and it was urged that, as he had been put to considerable expenditure, it would be unfair to interfere with him. Another member remarked that it would be "dishonest and unfair" of the committee to disturb Mr. Volk. To this it was replied that it was intended to come to terms with Mr. Volk, and give him his living out of the new tramway. The latter scheme, however, was vetoed by a large majority, only two voting in its favour.

Central London Railway.—According to the *Standard*, the system of cancelling tickets adopted on the Central London Railway has been found to lend itself to fraud when, at the busiest stations, large numbers of passengers are crowding through the barriers to enter the lifts. The traveller on this line is allowed to drop his ticket into the cancelling box, and as the attendant in charge can make little or no attempt to examine the tickets while he is working the hand-lever which performs the cancelling operation, there is nothing to prevent unscrupulous persons passing the barrier by dropping into the box tramway tickets or other imitations of the tickets issued by the Central London Railway Company. This has, indeed, been done in a number of cases, and it is understood that the directors are now considering how such a method of deception can be prevented. Experience has shown the necessity of several other changes. For instance, electric communication is being established at some of the stations between the platforms and the booking halls, so that a signal may be made to the lift attendant, indicating the approach of a train, this arrangement being needed to regulate the number of passengers who shall be allowed to descend to the platforms. With the present five-minute service, it has been impossible to avoid overcrowding at the Bank Station at certain periods of the day. On such occasions the 30 seconds allowed for stoppages at the platform has been considerably exceeded, with the result that the journey has been prolonged beyond the scheduled time, and intervals of 10 minutes between the running of trains have occurred. With the introduction of a more frequent service, it is believed that this difficulty will disappear. The average number of passengers on the railway has already reached a total of about 100,000.

Cleethorpes.—The *Yorkshire Post* says that satisfactory progress is reported with regard to the electric lighting scheme at Cleethorpes. As soon as the Urban District Council receive the necessary authority, they intend to acquire from the Tramways Company the power station which is to be erected on Poplar Road for the running of the cars by electric traction, and to extend the plant so as to provide current for street lighting. The contract for the erection of the station has been let by the company, who have already purchased the new cars at a cost of about £700 each. By next spring it is hoped to have the electric cars running throughout Grimsby and to Cleethorpes as far as Brighton Street, at the south end of the Promenade. A double set of rails is to be laid along Grimsby Road, and this work will commence in October. As soon as the Council have the necessary authority to augment the plant, the whole of the tramway route will be lighted by arc lamps. The negotiations with the Great Central Railway Company for the lighting of the Cliff Gardens, Pier, and Promenade by arc lamps are approaching completion. Unfortunately, there is some difference between the Council and the Tramway Company as to who will pay for the widening of Grimsby Road, but the difficulty is one which, it is hoped, will be overcome.

Cologne—Dusseldorf.—A financial daily says that a project is now being elaborated for the establishment of a lightning express railway service between Cologne and Dusseldorf, in Rhenish Westphalia. A speed of 120 miles an hour is suggested for an aerial railway of 33 kilometres in length.

Dundee.—At Monday's meeting of the Tramways Committee a communication from the Board of Trade was submitted, asking the Committee to reduce the speed at which the electric cars are run between the beginning of the Nethergate and top of Castle Street to four miles an hour. The manager reported that he thought six miles an hour should be allowed, and it was resolved to apply to the Board of Trade for permission to run at this rate.

Kearsley.—The District Council has received the authority of the Board of Trade for the use of electricity for traction.

Llanelly.—The *Western Mail* says that the scheme for establishing a system of electric cars at Llanelly is now to be proceeded with, terms having at last been arranged between the Insulated Wire Company and the proprietors of the existing tramways at Llanelly. It is proposed that the new service shall also embrace the outlying districts of Llwynhendy, Pwll, and Felinfoel. There will also be a complete installation of electric light. The estimated expenditure comes close to £100,000.

Liverpool.—It is understood that the Waterloo and Crosby Electric Tramway will be open for traffic on September 1st.

Rhondda.—Mr. Sellon and other representatives of the British Electric Traction Company waited on the Rhondda District Council recently to get the Council to withdraw its opposition to the light railway scheme. The Council's suggestions for street widening, &c., said Mr. Sellon, meant an expenditure of £14,000. The company were not prepared to do any widening beyond what had been submitted in their plans, but suggested that the question be left for the Light Railway Commissioners to decide. The Council refused to accept the suggestions, so the resolution to oppose the scheme holds good.

Royton.—The District Council has decided to apply for a provisional order for constructing tramways and supplying electricity within the district. The Oldham Tramways Committee are to be asked by the Royton District Council to receive a deputation to consider the question of tramways within the township. The Oldham Corporation have a clause in their new Bill by which they could construct or work the tramways if the District Council agreed after first obtaining an order. The Rochdale Corporation, who have also a similar clause in their tramway Bill, are also to be approached.

A short time ago the Chadderton District Council asked the Oldham Corporation to construct certain tramways within their district, but no reply has yet been received, although the Committee have visited the suggested thoroughfares. At the Council meeting this week another route—from Chadderton Church through Streetbridge to Royton—was also placed on the list.

Lees District Council evidently do not understand what their position is with regard to tramways being run through their district, and to solve the matter a deputation will wait upon the Oldham town clerk.

South Lancashire.—The generating station for the new South Lancashire Tramways is, according to the plans laid before Parliament, to be at Leigh, which lies pretty nearly about the centre of the proposed network of tramways connecting Manchester and Wigan, St. Helens and Bolton.

Stretford.—The Urban District Council have at length come to an agreement with the Manchester Corporation, by which they undertake to lease to the last-named body the tramways in their district for a period of 21 years, the cost of buying out the Carriage Company, together with the cost of the reconstruction of the tramways, to be repaid to the Council by the Corporation during the period of the lease, the Corporation in respect of electrical equipment to pay 6 per cent. per annum on the capital outlay, and all rates and cost of maintenance.

TELEGRAPH AND TELEPHONE NOTES.

African Telegraphs.—A Berlin daily press dispatch says that the preparations for laying the telegraph from Dar-es-Salam to Kilossa, in German East Africa, began about the middle of July. The German Postmaster-General has promised to ask for 200,000 marks in the next Budget, and has stated that the telegraph must reach Ujiji prior to Mr. Rhodes's "Cape to Cairo" telegraph.

Cablegrams by Telephone.—For the last five years the Liverpool Chamber of Commerce have been endeavouring to obtain concessions from the Postmaster-General, the cable companies, and the National Telephone Company, whereby cable messages received from abroad after business hours—6 o'clock p.m. —might be transmitted by telephone to addressees and replies received by the cable companies for transmission abroad. Certain facilities were granted, but they were not such as to meet the convenience of the mercantile community of Liverpool in the way desired, and negotiations were resumed. Mr. Charles McArthur, Member of Parliament for the Exchange Division—the mercantile division—of Liverpool, as representing the Liverpool Chamber of Commerce, has been in communication with the Postmaster-General on the subject, and the facilities asked for will snortly be granted. The correspondence which has passed between Mr. McArthur and the Postmaster-General appeared in the daily papers on Wednesday.

Chinese Telegraphs.—Reuter's agent at Shanghai stated on 21st inst.:—"Foreign officials here have received information that the telegraph from Tientsin has been cut." A despatch from Copenhagen on August 21st stated that the Great Northern Telegraph Company announces that the new cable between Taku and Chifu had been opened for traffic. A Central News telegram, dated Shanghai, August 19th, says that the Imperial Telegraphs Administration announce that, relying upon international protection, they will at once proceed with the repair of the land lines between Taku, Tientsin, and Peking.

German-American Cable.—A telegram from New York on the 16th inst., stated that the cable steamer *Angila* had connected up the sea cable of the new German-American cable, and had commenced laying down the portion of the cable from America to the Azores.

Portsmouth Telephones.—On Tuesday a sub-committee of the Finance Committee of the Town Council considered a report which had been prepared by Mr. Bennett, telephone expert, of Glasgow. In his estimate of the cost of the municipal system, he had made provision for every item of expenditure, including rates, sinking fund, &c., and it worked out to £19 10s. as the initial cost per instrument to the Corporation, but at the end of 25 years the whole of the loan would have been paid, and the undertaking become the property of the borough. To meet the expenditure and allow for contingencies, Mr. Bennett calculated that the following scale of charges would have to be adopted: For an unlimited service, £5 17s. 6d.; for a limited service, with ½d. per call, £3 10s.; for a limited service with 1d. per call, £2 10s. As the number of subscribers increased, however, these charges could be reduced. Mr. Bennett had prepared two schemes—one for 1,000 subscribers and the other for 2,000, with in each case public telephone bureau (call offices) in different parts of the borough. At £19 10s. per subscriber, the cost of the two schemes would work out roughly at £19,500 and £35,000. It was decided to recommend that the necessary steps be taken to ascertain whether a sufficient number of subscribers will come forward, and in that event it will be proposed to recommend for adoption one or other of the schemes submitted.

The Telegraphists and Lord Londonderry.—About a month ago an application was made by the Central Committee of the Postal Telegraph Clerks' Association, which has its offices at Liverpool, for permission for a deputation of six delegates to wait upon the Postmaster-General for the purpose of laying before his Lordship certain grievances from which they considered the telegraphists to suffer. The delegates were chosen from Liverpool, Newcastle-on-Tyne, Glasgow, London, and Belfast. The points with which they wished to deal were (1) the necessity for an increased maximum pay, and (2) a quicker flow of promotion; (3) the permanent arrestment of increments; (4) the insufficient pay after five years' service, and (5) the rights of combination. After some consideration, Lord Londonderry has now replied to the application through the medium of the Postmaster of Liverpool. He says nearly all the points which the applicants desired to bring forward have been dealt with in the report of the Tweedmouth Committee, and cannot be considered as open for discussion at present. On others, such as the alleged stagnation of promotion, the dual increment, and the conditions of service in the smaller offices, his Lordship had recently received representations from a deputation of Members of Parliament (including Sir Albert Rollit, Mr. Steadman, Mr. Jacoby, Mr. P. O'Brien and others), and from a deputation of the United Kingdom Postal Clerks' Association (Messrs. Brodie and Cartwright). These matters were now engaging his attention, and he did not think any useful purpose would be served by further interviews at present. But if he found that any further information was required, he would communicate with the applicants again later on. As regarded the last point mentioned, viz., the restoration of deferred increments, the present regulations were based upon an Order in Council, which was applicable to the whole Civil Service, and the Postmaster-General had no power to make an exception in favour of the staff of his department. The note was signed by Sir Geo. Murray, and dated August 10th. It is known that the Postal authorities resisted the application of the Order in Council referred to, to its own staff, but were overruled by My Lords.

Uganda Railway Telegraphs.—In a Parliamentary paper on the progress of the Mombasa-Victoria (Uganda) Railway in 1899-1900, it is reported that a permanent telegraph line with three wires has been completed to Nairobi, mile 326, and with two wires to mile 362. The erection of a light line was undertaken for the Protectorate, and carried through to Kampala.

Wireless Telegraphy.—According to certain daily papers the Dover Chamber of Commerce have received most satisfactory promises of support in the action they are taking to get the wireless telegraphy installation that connected the East Goodwin lightship and the shore reinstated, as it proved on several occasions of such practical value in cases of collision. The chamber have memorialised the Board of Trade and Trinity House, and will bring the question forward at the autumnal meeting of the Association of Chambers of Commerce to be held at Paris next month, and amongst the chambers whose support they have obtained are Liverpool, Southampton, Bradford (Yorks), Hull, Middlesbrough, Wakefield, Oldham, Leith, Goole, Nottingham, Exeter, Walsall, Bolton, Newport, &c.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—August 25th. The Corporation invites tenders for steel poles, bases and brackets, for tramway equipment. See "Official Notices" August 10th.

Aberdeen.—August 28th. The Electric Lighting Committee wants tenders for a 12 months' supply of cables, meters, and house main fuse boxes. See "Official Notices" August 17th.

Aberdeen.—September 29th. The Electric Lighting Committee wants tenders for two 200-kw. direct coupled continuous current generators, and one 120-kw. balancing set; one 420-kw. direct coupled generating set. All Willans engines. See "Official Notices" to-day.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Budapest.—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

Cardiff.—August 31st. The Corporation wants tenders for sundry pipes, feed-water heater, &c., for the electricity works. See "Official Notices" August 17th.

Fulham.—The Vestry wants tenders for elcctric wiring at the Town Hall, Walham Green. See "Official Notices" August 10th.

Germany.—August 30th.—The municipal authorities of Dusseldorf are inviting tenders until the 30th inst. for the supply and erection of two 3-ton overhead electric travelling cranes and two 4-ton ditto. Particulars may be obtained for 2s from, and tenders are to be sent to, Die Oberbürgermeister, Stadtbaumt III. Dusseldorf.

Germany.—September 10th.—The Hamburg Finance Deputation is inviting tenders for the supply and erection of two 30-ton electric cranes. Particulars may be obtained for 3s. from the Secretariat II. der Finanz Deputation (Rathhaus Ober-Erdgeschoss, Zimmer 429), and tenders marked 339 are to be sent to Die Finanz Deputation, Hamburg.

Greenock.—September 10th. The Police Board requires tenders for water-tube boilers, steam dynamos, boosters, switchboard, piping, &c., for electric traction. See "Official Notices" to-day.

Hackney.—September 12th. The Electric Lighting Committee is wanting tenders for the supply of condensing plant, cooling apparatus, pipe work and valves, feed pumps, switchboard and boosters, arc lamps, meters, crane and workshop equipment. See "Official Notices" August 17th.

Hammersmith.—September 12th. The Vestry wants tenders for two single-phase alternate current motors coupled to two centrifugal pumps. See "Official Notices" to-day.

Hampstead.—September 27th. The Vestry invites tenders for eight marine boilers, piping, feed-heater or detartariser, fuel economiser, and tanks. See "Official Notices" to-day.

Hanley.—August 25th. The Electric Light Committee is inviting tenders for two Lancashire boilers, fuel economiser, smoke chimney exhaust fan, feed-water heater, forced draught fittings, coal conveyor and bunkers, also various accessorial plant and apparatus for the electricity works. Specifications, &c., from the borough engineer or the Corporation electrical engineer, for 5s.

Hull.—September 27th. The Corporation wants tenders for certain steam and water pipes, pump, water softener, &c., for electricity works. See "Official Notes" to-day.

Ilford.—August 29th. The District Council wants offers from firms willing to take up free wiring in the district. See "Official Notices" August 17th.

London County Council.—September 22nd. Tenders are wanted for boilers, engines, dynamos, &c., at the Horton Estate, Epsom, Surrey. See "Official Notices" August 10th.

Luton.—September 14th. The Town Council invites tenders for watt-hour and demand meters. See "Official Notices" August 3rd.

Manchester.—August 25th. The Tramways Committee wants tenders for cast-iron bases for tramway poles. See "Official Notices" August 17th.

Nelson.—September 8th. The Corporation wants tenders for a 200-KW. steam dynamo. Specifications from Mr. Allen, engineer at the gas works. £2 2s. deposit.

Newcastle-on-Tyne.—August 31st. Tenders are wanted by the New Tramways Committee for conduits and holes for poles. Specifications (£3 3s. deposit) from the consulting engineer, Mr. C. Hopkinson, London and Manchester.

Plumstead.—September 19th. The Vestry wants tenders for boilers, refuse destructor, steam fittings, economiser; steam piping, pumps, &c., &c.; steam generators—two 300-I.H.P.; two 150-I.H.P.; and one 100-I.H.P.; condensing plant, cooling tower, &c.; switchboard; battery; traveller; mains, meters, arc lamps and posts, &c. See "Official Notices" August 10th.

Portsmouth.—September 4th. The Corporation wants tenders for the complete equipment of the tramway power station. See "Official Notices" August 3rd.

Preston.—September 10th. The Guardians want tenders for an electric light installation at Fullwood Workhouse. See "Official Notices" to-day.

Salford.—September 3rd. The Corporation wants tenders for a lighting switchboard, traction ditto, and balancing transformers. See "Official Notices" August 10th.

Shipley (Yorks).—August 27th. The Council wants tenders for steam and exhaust pipes, battery, switchboard and connections, and cables for electricity works. See "Official Notices" August 17th.

Southampton.—September 10th. The Harbour Board wants tenders for a 30-cwt. portable electric crane. Specification from Mr. Bowyer, Harbour Offices, Town Key. Deposit £5.

Southampton.—September 11th. The Guardians want an electric lighting plant erected at the new workhouse infirmary, Shirley Warren. Particulars from Mr. J. Aldridge, 9, Victoria Street, S.W.

Stockport.—August 31st. The Tramways Committee wants tenders for 20 double-deck tramcars with electrical equipments. See "Official Notices" July 13th.

Warsaw.—August 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Acting Consul-General at Warsaw stating that tenders are invited by the Russian Government, not later than the 28th prox., for the telephone service of Warsaw, St. Petersburg, Moscow, Odessa, and Riga Some particulars may be examined at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Whitby.—September 3rd. The Council wants tenders for the supply of two water-tube boilers, pumps, condensers, pipes, &c.; two steam dynamos, balancer, and boosters; switchboard and connections; battery; travelling crane; cables, arc lamps, &c. See "Official Notices" August 10th.

Worthing.—September 3rd. The Corporation wants tenders for three 96-KW. steam dynamos, two marine boilers, steam and other piping and condensing plant, manhole covers, arc lamps and posts, stoneware casings, cable work, battery, balancing transformers and motor-generators, economiser, and 5-ton traveller. See "Official Notices" August 17th.

CLOSED.

Blackpool.—The Electric Lighting, &c., Committee has placed contracts with the following firms:—Leeds Steel Works, for rails; Messrs. Askham Brothers & Wilson, for points and crossings; Mr. Leonard Cooper, for patent jointing materials for tramways; Messrs. Lowther Bros., for trolley poles, storage battery, boosters, and switchboards; and the St. Helen's Cable Company, for cables and trolley wires. They are for the Marton tramways, and the total amount is £27,000.

Cardiff.—A special meeting of the electrical committee was held last week to consider tenders for steam pipes. There was but one tender. Mr. Appelbee read letters from three firms, who said that the time allowed between the appearance of the advertisement and the date that the tenders were required was not sufficient. The committee decided to re-advertise.

Cardiff.—Messrs. Dick, Kerr & Co., Limited, have received a contract to supply 1,000 tons of rails and 40 tons of fish-plates for the Corporation trams at £8,522. The fish-bolts and nuts will be supplied by Ibbotson Bros., of Sheffield; the sole plates, points and crossings, and drain rails by Askham Bros. & Wilson; and the bonds by Messrs. Felten & Gilleaume.

London.—The Shoreditch Vestry on Tuesday considered the undernoted tenders for the supply of cable:—

British Insulated Wire Company (accepted)	£1,930 8 2
W. T. Glover & Co.	2,129 12 6
Henley's Telegraph Works Company	2,147 15 1
Siemens Bros. & Co.	2,262 8 4

Warrington.—The Council has accepted the amended tender of Messrs. Johnson & Phillips for cast-iron pillars for arc lamps at £987.

NOTES.

Electrical Development on a Large Scale for Melbourne.—The *Financial Times* Melbourne correspondent gives details of a gigantic electrical scheme for the neighbourhood of Melbourne. He says:—

Some time ago I hinted that a gigantic corporation was being formed here to acquire and sell to a British company certain rights to supply electric power and engage in electric traction. Further particulars of this matter have now come to light. The new company is being promoted by Mr. Reginald A. F. Murray, and the secretary is Mr. T. Holyrood. These gentlemen, it is stated, have the assurance of Major Cardew, of the firm of Sir William Preece and Cardew, of London, after careful examination of the plans, reports, routes, &c., that everything in connection with the undertaking could be practically carried out with financial success. It is estimated that to lay down the plant, &c., will cost £3,000,000, and in all it is likely that about £7,000,000 will be required. Before the company can commence operations a private Act of Parliament must be passed, and the necessary power obtained from various local authorities to carry out the scheme. The corporation here has applied to all the municipal councils within the metropolitan area for permission to run electric mains through their respective areas, and a conference to consider the question is, it is said, to be called. The aims of the company are far more gigantic than at first given out. It proposes to generate electricity at a main station at Wyndham, 11 miles from Melbourne, on the shores of Port Philip Bay, just past Williamstown, and the mains are to be conveyed underneath the Yarra through a tunnel, for which the necessary sanction has been granted by the Harbour Trust. It is proposed to work the deposits of brown coal—said by the promoters to be extensive—at Altona Bay on Straubel's system. Electricity will be supplied to every house in the metropolitan area for all purposes, including cooking. All household requisites, cooking utensils, motors, meters, &c., will be at disposal on the hire principle, and will be within reach of all. If the Government be willing, the company will supply sufficient power to run all the suburban railroads and tramways. It is intended to construct 103½ miles of electric tram lines in the streets and off-streets not already touched by cable cars; it is proposed to erect large smelting works for dealing with all classes of refractory and crude ores, including those having gold, copper, iron, tin, and zinc contents. In fact, the proposals of the company are so extensive that it takes some time to comprehensively grasp their real meaning. The good people of Melbourne are rather inclined to treat the affair as a huge joke, but there are signs that the scheme is being pushed from some influential quarters. Who is to supply the £3,000,000 or £7,000,000? Investors in the colony will not do it—hence the money will doubtless be sought in London.

Personal.—The Council of University College, London, have appointed Mr. G. Carey Foster, B.A., F.R.S., Principal of the College. Mr. Carey Foster is a Fellow of the College, and has held the offices of Professor of Experimental Physics and of Quain Professor of Physics. He is also a Fellow of the University of London, in which University he acted as examiner previous to his election to the Senate. Owing to this appointment and to the retirement of Mr. J. M. Horsburgh, the secretary of the College, there will be a reorganisation of the administrative and executive department of the College. Pending the completion of this reorganisation, the Council have invited Dr. Gregory Foster, Fellow of the College and Professor of English Language and Literature at Bedford College, to temporarily hold the office of secretary, and he has accepted the invitation.

It is announced that Major R. E. B. Crompton, of the Electrical Engineer Volunteers, who is now serving in South Africa, is to be appointed lieutenant-colonel in his corps on his return.

Electricity in the German Navy.—The *Electrical World* abstracts from the *Elek. Anz.* an article giving a summary of the development of the use of electricity in the German Navy. From this it appears that while until about 1895 electricity was used there only for lighting, it is now used also for power purposes, for driving the ventilators, turrets, &c. Electric transmission of signals, orders, &c., has come into considerable use in recent years; for this purpose storage batteries are connected in parallel with the generators to supply current in case an accident should occur to the generators. One of the largest electric installations is on the *Fuerst Bismarck*, where there are five generators, each of 65 KW., the voltage being 110.

Electric Traction Progress.—Ten to fifteen years of hard work has not played out the electric traction industry of the United States. Most reports of American work still strike the keynote of progress and continued development. There is, of course, enormous scope for extensions over there, hence although so much has been already done, present contracts indicate that the business is on as firmly established a basis as it ever was. Our own country is now fairly awake to the need of electrical development and while the opportunity will not arise for the same wholesale equipment of new lines as in the States, it is pretty clear to all who have given the matter a moment's thought that the development which is now taking actual shape in this country will be on an enormous scale, running into many million pounds worth of business. The New York *Electrical Review* recently made some remarks upon the position on the other side in the following hopeful strain;— "It is impossible for one looking over the newspapers and other sources of information which come to the office of a technical journal of this character, to avoid being forcibly struck with the enormous extension of the electric railway in the United States. There must be at this minute several thousand miles of new construction under way. Nearly every important trolley system in the United States is extending its lines and new ones are constantly cropping up; combinations are being formed everywhere between existing lines, missing links are being built, and already trolley systems have extended themselves so as to reach over distances of more than 200 miles. Another summer of such extraordinary activity will fairly gridiron the eastern and middle Western States with a continuous network of trolley roads, rivalling that of the steam railways now in existence. It is hard to predict the future of a movement so vast and so natural. There has been nothing like it in history, unless, perhaps, one looks back to the early days of railroad building in England. What its effect will be upon the steam railroads it is very difficult now to say, except that it furnishes them with a continual (and often exceedingly expensive) object lesson of superiority of the electric motor, and of the popularity and convenience of the single car train travelling along the highway and stopping wherever a passenger wants to get off or on. The subject is too large to discuss in the space at command, but for the thinking railway manager it must be to-day the most important subject for consideration."

Electric Railways v. Omnibuses.—The chairman of the London General Omnibus Company was asked by a shareholder, at last week's meeting, what effect the Central London Railway was likely to have upon the omnibus traffic of the company. In reply, he stated that the Central London Railway had made a difference in the receipts on some of their lines, but, judging by the experience of the past, the effect would be quite temporary, as the nerves of the London omnibus business were sensitive and sensible enough to adapt themselves to any divergence of the traffic.

American Electro-Therapeutic Association.—The forthcoming Convention, to which we referred last week, will consider in addition to reports by the various standing committees, a large number of papers on electro-medical topics covering every branch of the subject of electro-therapeutics. They will be as follows:—

"On Galvanisation," by Prof. A. Tripier, M.D., Paris, France.

"Electro-Therapeutic Sins," by Rev. H. Newman Lawrence, New York.

Discussion: On electricity in Tuberculosis and present modes of treatment.

"Ethiology of Tuberculosis, its course and termination," by S. A. Knopf, M.D.

"What are the present most Successful Methods of Treatment," by M. J. Brooks, M.D.

"Electric Light as a Therapeutic Agent," by C. O. Files, M.D.

"Electric Light as a Therapeutic Agent in Diseases of the Throat and Lungs," by Wolff Freudenthal, M.D.

Report of the practical value of Grott's Method and of others who advertise cures.

The possibilities of Electricity in the line of Specific Treatment.

"The Treatment by the Galvanic Battery in private practice or Sanatorium," by A. L. Sherman, M.D.

"Cataphoresis: Is it plausible or practical, and the Therapeutic Agent suggested?" By Margaret A. Cleaves, M.D., New York E. B. Silvers, M.D., Rahway, N.J., and others.

"Electro-Therapeutic Terminology," by W. J. Herdman, M.D.

"The value of Electricity in Diagnosis and Prognosis," by W. M. Leszinsky, M.D., New York.

"A plea for the better application of Electricity in Diseases," by J. Griffith Davis, M.D.

"New advances in Coil Interrupters for X-Rays," by Mr. E. W Caldwell, E.E.

"Combined Electrization or Galvano-Faradisation," by A. D Rockwell, M.D.

"Gleanings in the field of Electro-Therapeutics," by Chas. O. Files M.D.

"Electricity as a Remedial Means," by W. S. Watson, M.D.

"Electricity in Acute Diseases," by Laura M. Reville, M.D.

"Treatment of Gonorrhœal Urethritis in the Male by Galvanic Electricity," by S. W. Smith, M.D.

Discussion: Electricity in Gynecology and the present Reluctance of Gynecologists to use Electricity.

"The General Office Work of a Gynecologist," by Fred. D. Morse, M.D.

"Treatment of Gynecological Cases with the Static Electricity," by William J. Morton, M.D.

"Treatment with Faradic and High Tension Currents," by F. Schavoir, M.D.

"The Nervous Diseases Peculiar to Women," by G. Betton Massey, M.D.

"Use of the Continuous Current and Electrolysis," by Robert Newman, M.D.

"Treatment of Uterine Diseases with Electricity," by Prof. F LaTorre, M.D.

"Static Massage in Sub-Acute and Chronic Muscular Rheumatism," by F. Schavoir, M.D.

"Some general Statistics of Strictures of the Urethra, treated by Electrolysis," by Robert Newman, M.D.

"The Choice of a Coil for use with currents of High Amperage by R. J. Nunn, M.D.

"Spark Gap Currents, viz: Franklinic Interrupted, Static Induced Wave Currents," by William J. Morton, M.D.

"Illustrations of the Value of the Cataphoric Method in Cancer," by G. Betton Massey, M.D.

"A Universal Electro-Therapeutic Switchboard," by Wm. J. Herdman, M.D.

"The Causes of some cases of Neurasthenia and their Treatment by Electricity," by Francis R. Bishop, M.D.

"X-Ray Photography," by E. R. Corson, M.D.

"A new form of Fluid Interruptor for using direct current," by Emil Heuel, M.D.

Lecture on Methods of Generating and Transforming Electric Currents for Therapeutical uses. By Mr. Charles T. Child, E.E., Technical Editor of the *Electrical Review*, New York.

"Electricity in Ocular Practice," by Maurice F. Pilgrim, M.D.

News from the International Electric Congress in Paris, by D. Percy Hickling, M.D.

"Electricity in the Treatment of Dilatation of the Stomach," by John A. Lichty, M.D.

There is an abundance of other papers from different authors in the United States and abroad, of which no exact titles can be given now. The amount of work arranged by this well organised Association for a three days' conference, is really remarkable. Our list merely mentions the papers, but in addition there are numerous addresses, visits and so forth customary on these occasions.

A Cure for Dyspeptics!—The sooner the Central London Railway directors put on their extra trains the better. The line is bound to be besieged shortly, for a *Daily Mail* correspondent, who has not been able to eat anything for 18 months, says that travelling on this deep level line has given back to him a ravenous appetite, so that he can now dispense with his accustomed tonic! He puts it down to "ozone generated by the electricity." Now we know why there has been such good traffic on this railway, and it also partly explains why the overstrung stockbroker takes his trips to West End restaurants for the midday lunch. We congratulate the board on the great promise for the future, while we at the same time commiserate with the medical profession and the city clerk who has to eat two penny buns where he once ate only one. The longing for a sniff of the briny breezes gives place to a clamour for the vaultlike odours of the bowels of the earth—for a trip to the Bush in the "tuppenny tube."

Non-Inflammable Dielectrics.—Mr. Standage, in a recent issue of *Engineering*, directs attention to the inflammable properties of the ordinary materials used for insulating purposes for street mains; and suggests that a non-fusible substance should be sought, with a view to diminishing the dangers that lurk in electrical installations. He points out that gutta-percha melts at a low temperature and is very inflammable, and that this is also the case with shellac and paraffin wax. But he has observed that glue may be utilised as a less fusible and less inflammable basis for a dielectric. There is a good deal to be said in favour of going wider afield for dielectrics. Glue, and the gelatines generally, may be treated in many ways so as to render them water-proof, and it is quite possible that for some purposes an effective dielectric could be obtained from a judicious mixture of this character. It is doubtful, however, whether it would be durable, and it is more than doubtful whether it would satisfy the specifications to which manufacturers have to fabricate their wares. "Nevertheless," as a nobleman once remarked, "there is something very loving about glue." We hope Mr. Standage will adhere to it, and bringit off.

The Sydenham Boiler Explosion.—Mr. E. N. Wood, Deputy-Coroner for West Kent, resumed at Lewisham, on 17th inst., the inquest on the bodies of Frederick Elliston, 33, and William Philbrook, 19, who met their death in a boiler explosion which took place on the premises of the Crystal Palace District Electric Supply Company on the 25th ult. On this occasion the Deputy-Coroner had the assistance of Mr. J. Owner, one of Her Majesty's Inspectors of Factories. Mr. Walter Phillips, electrical engineer to the company, said that every year until this year the boiler had been thoroughly examined. The reason why it was not done this year was because the company were busy, and could not let the boiler be idle, as the examining process took over a week. Since the explosion Witness had examined the fragments of the boiler, and found flaws. In his opinion those flaws were the cause of the explosion. After further evidence had been taken the Jury returned the following verdict:—"That the deceased men died suddenly from injuries caused by an explosion of a boiler, due to its defective condition, which might have been discovered had the boiler been thoroughly examined, as it ought to have been, between April of last year and the date of the explosion."

Electric Light in Mines.—From the evidence given at the inquest on the bodies of the eight men who lost their lives through an explosion at Old Boston Colliery, it appears that the men worked with electric lights and naked lights, candles being placed at the side of the pit about four yards from the bottom. The colliery manager said that naked lights were never prohibited, and were introduced because the electric lights could not be moved low enough down. The jury added to their verdict of "Accidental death" a recommendation that only safety lamps or electric lights should be used in pit sinking.

The Bolton Appointment.—The Tramways and Electricity Joint Committee of the Bolton Corporation find themselves somewhat in a difficulty regarding the appointment of a successor to Mr. Arthur Ellis, M.I.E.E., as borough electrical engineer and general manager of the electric tramways. There were originally 44 applications for the position, and these were reduced to 12. Subsequently four out of the 12 selected were invited to attend before the Joint Committee, namely, Mr. A. A. Day, assistant electrical engineer to the Manchester Corporation; Mr. J. A. Jeckell, borough electrical engineer at South Shields; Mr. H. F. Street, borough electrical engineer to the Halifax Corporation; and Mr. W. R. Wright, borough electrical engineer at Bootle. After a three hours' sitting, the Joint Committee decided unanimously to give the appointment to Mr. Street, but that gentleman, on being informed of the decision, is said to have asked for time to consider the offer made him. At the conclusion of the meeting of the committee official information was withheld from members of the press beyond the bald statement that, "subject to certain conditions, one of the selected candidates would be appointed." The commencing salary offered is one of £500 per annum, advancing by yearly increases of £50 until the maximum of £750 is reached.

Will.—The whole of the estate of Mr. B. H. van Tromp, who died last October, has been valued at £54,081 gross, including personalty valued at £42,042. He was a director of the Brush Electrical Engineering Company, Limited, the County of London and Brush Provincial Electric Lighting Company, Limited, the Dover Electricity Supply, Limited, the Electric and General Investment Company, Limited, and several other companies.

Electrical Treatment for Lead-Poisoning.—It is stated that the necessary money (£150) having been subscribed, principally through the influence of the Duchess of Sutherland, an offer has been made to provide the North Staffordshire Infirmary with electrical apparatus of the most modern description (available for baths, X-ray investigations, cautery, &c.), for the treatment of lead-poisoning. This offer has been gratefully accepted by the authorities of the institution.

Appointments Vacant.—The Darwen Tramways Committee is wanting a working foreman to take charge of the electrical equipment of the cars and overhead equipment under the electrical engineer, at 45s. per week. Applications to the Town Clerk by 29th inst.

Two shift engineers at £104 are required for the South Shields electricity works.

A borough electrical engineer at £200 per annum is wanted by the Eccles Corporation. See "Official Notices" to-day.

Works Sale.—A local correspondent informs us that the works of the Madelvic Motor Carriage Company at Granton were sold by auction in Dowell's rooms, Edinburgh, on August 22nd, at the upset price of £7,000. They were purchased by Messrs. Galbraith & M'Call, Glasgow, for a client. The works were started about a couple of years ago to make electric motors on a system that would give the maximum power with a very small weight, but the company were never able to bring out a workable machine, and went into liquidation.

NEW COMPANIES REGISTERED.

Johnson Electro-Germicide Company, Limited (66,925).—This company was registered on August 9th, with a capital of £2,000 in £1 shares, to adopt an agreement with C. M. Johnson, for the acquisition of a patent for improved means of destroying disease germs, and of the electrical generating machine now standing in the Research Laboratory at Savoy Street, Strand, and to manufacture and deal in electrical and other apparatus, chemicals, drugs, medicines, &c. The first subscribers (each with one share) are:—J. M. E. Lloyd, 35, Wynnstay Gardens, Kensington, W., gentleman; A. Winfield, 56, Tubbs Road, Willesden, clerk; Mrs. I. M. Welch, 35, Sloane Street, S.W.; F. H. Lloyd, 82, Sinclair Road, Kensington, W., gentleman; C. M. Johnson, 11, Routh Road, Wandsworth Common, S.W., scientist; H. Moulton, 37, Chancery Lane, W.C., clerk; and G. C. Brown, 37, Chancery Lane, W.C., clerk. The number of directors is not to be less than two nor more than five; the first are to be appointed by the subscribers; qualification, one share.

Turner, Atherton & Co., Limited (66,901)—This company was registered on August 8th, with a capital of £175,000 in £1 shares, to acquire the businesses now carried on by (1) John Turner & Sons, of Denton, Lancs., electrical engineers; (2) John Turner, of Denton, Lancs.; (3) The Turner Machine Company, of Danbury, Connecticut, U.S.A., hatters' machinists and merchants, engineers, founders, hat block frame and flange makers, hardwaremen, steam, water and gas fitters, &c.; (4) Turner Bros., of Danbury, Connecticut, U.S.A., hatters' merchants, &c.; and (5) Giles Atherton, of Stockport, Cheshire, hatters' machinist and merchant, felt hat body manufacturer, felt hat former, fur blower, clearer or cleaner, importer and exporter; and to carry on the said businesses and the business of mechanical engineers, wheelwrights, tube makers, screw, bolt and nut manufacturers, bicycle, tricycle, velocipede, motor cycle, and motor car manufacturers, platers, lamp makers, india-rubber merchants, &c. The first subscribers (each with one share) are:—H. H. Turner, 373, Manchester Road, Denton, Lancs., engineer; Albert Turner, Whitehouse Ironworks, Denton, Lancs., engineer; Arnold Turner, Danbury, Connecticut, U.S.A., engineer; Mrs. J. Turner, Prospect House, Denton, Lancs.; G. Atherton, Virginia Villa, Mile End, near Stockport, Chester, hatters' machinist; W. H. Atherton, Virginia Villa, Mile End, near Stockport, Chester, hatters' machinist; G. H. Rowse, Cartwright Street, Hooley Hill, cashier. Henry H. Turner, Albert Turner, Arnold Turner, and Giles Atherton are permanent governing directors; William H. Atherton and William E. Turner are managing directors. Registered office, Turner Street, Denton, Lancs.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric and General Investment Company, Limited (31,506).—This company's annual return was filed on July 23rd, when 20,000 ordinary and 100 founders' shares were taken up out of a nominal capital of £200,000 in 39,900 ordinary and 100 founders' shares of £5 each. £1 per share has been called up on the ordinary, and £5 per share on the founders' shares, resulting in the receipt of £20,500.

Edmundson's Electricity Corporation, Limited (52,013).—This company's annual return was filed on July 26th, when 40,000 shares were taken up out of a nominal capital of £400,000 in £5 shares. £5 per share has been called up on 26,800, resulting in the receipt of £134,000; 13,200 shares are considered as fully paid. The capital has been recently increased from £200,000 to £400,000.

West African Telegraph Company, Limited (21,626).—This company's annual return was filed on July 4th, when 23,109 shares were taken up out of a nominal capital of £400,000 in £10 shares. £231,090 has been paid.

Thomas Parker, Limited (40,973).—This company's annual return was filed on July 17th, when the entire capital of £75,000 in £10 shares had been taken up; £10 has been called up on each of 5,750 shares, resulting in the receipt of £57,500; 1,750 shares are considered as fully paid.

SUPPLY STATION ACCOUNTS.

Kingston-upon-Thames Corporation Electricity Accounts.

The accounts for last year of the Kingston Corporation electricity undertaking show that the business has reached the turning point where a net deficit will be turned into a surplus, and we extend our congratulations to Mr. J. E. Edgcome, the Borough Electrical Engineer, upon having brought the undertaking to this state. The history of the department from 1893 shows that in that year and in 1894 there was a gross loss upon the working; in 1896 the first turning point was passed when the gross profit reached £300, but this did not nearly cover the annual interest payable. Since that year the profit, after payment of interest, has steadily increased, but is not yet quite sufficient to meet the charges for repayment of capital.

Owing to the large payments in 1898, under the heads of interest and sinking fund, the total deficit was larger than in the previous year, notwithstanding that the profit on the working had considerably increased. Large sums were spent upon buildings, plant and cable, which had only commenced to earn a revenue. Although the revenue will increase year by year it is not anticipated that the financial charges will increase at all proportionately.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£44,813	**£50,674**	£5,861
Number of units sold	232,370	**364,000**	131,630
Number of lamps connected ...	11,856	**16,130**	4,274
Gross revenue	£4,701	**£7,512**	£2,811
Gross expenditure	£3,480	**£4,775**	£1,295
Gross profit	£1,221	**£2,737**	£1,516
Average price per unit sold ...	4·70d.	**4·80d.**	+ ·10d.

At the end of the last financial year 311 consumers were connected to the mains, an increase of 100 during the 12 months. The number of lamps connected was 16,130. Of the output private consumers took 264,155, and the public lamps 99,845 units. Curiously enough the receipts per unit have risen by about $\frac{1}{10}$d., notwithstanding that motive power supply is being encouraged, for which purpose a reduced price of 3d. per unit is now being charged.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£4,547	4·70d.	**£7,280**	4·80d.	+ ·10d.
Meter rents	133	·14d.	**179**	·12d	− ·02d.
Sundry sales	21	·02d.	**53**	·03d.	+ ·01d.
Fees, &c.	...	...	...	...	...
Gross revenue ...	£4,701	4·86d.	**£7,512**	4·95d.	+ ·09d.

With the exception of "Establishment Charges," the items in the cost sheet show reductions which have brought the figures out very creditably for a works labouring under the geographical disadvantages of Kingston. "Coal" is reasonable at 1·6d. but a very favourable coal contract was made in 1899 some months before the abnormal rise in prices. A total cost of 3¼d. per unit shows that in the items over which the engineer has control every economy is exercised.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£1,751	1·81d.	£2,408	**1·59d.**	− ·22d.
Oil, waste, water and engine room stores.	175	·18d.	220	**·15d.**	− ·03d.
Salaries and wages incurred in generation and distribution.	508	·52d.	613	**·40d.**	− ·12d.
Repairs and maintenance of buildings, engines, boilers, dynamos, and attending carbons, and repairs public lamps.	508	·52d.	716	**·47d.**	− ·05d.
Works costs ...	£2,942	3·03d.	£3,957	**2·61d.**	− ·42d.
Rent, rates and taxes ..	134	·14d.	160	**·10d.**	− ·04d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	276	·28d.	405	**·27d.**	− ·01d.
General establishment charges, stationery and printing, law charges and insurance	113	·12d.	228	**·15d.**	+ ·03d.
Other expenses (lamps, stores, &c.	15	·02d.	25	**·02d.**	− ·00d.
Total costs ...	£3,480	3·59d.	£4,775	**3·15d.**	− ·44d.

We have already alluded to the financial results of the year's working. It only remains to again remark upon the material improvement shown by a betterment of well over £1,000 in the final result, and to express the hope that the current year will, despite the gloom it has brought, mark the first net profit of this undertaking.

Profit Statement.

	1898.	1899.
Interest on loans	£1,102	£1,439
Sinking fund for repayments	1,231	1,346
Net profit (being deficit balance)	−1,112	−48
Gross profit	£1,221	£2,737

Dewsbury Corporation Electricity Accounts.

The Dewsbury Corporation accounts dealing with the electricity supply department, contain the satisfactory announcement that last year, for the first time, there is a balance on the right side after paying the sums due as interest and redemption. This, Mr. O. M. Jonas, the borough electrical engineer, believes is chiefly due to the fact that the mains have been extended in the residential district, and new customers for the department have, therefore, been obtained.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£26,691	**£33,229**	£6,538
Number of units sold	161,154	**199,924**	38,770
Maximum load in kw.	190	**230**	40
Number of lamps connected ...	10,128	**13,028**	2,900
Gross revenue	£3,349	**£4,101**	£752
Gross expenditure...	£2,340	**£2,355**	£15
Gross profit	£1,009	**£1,746**	£737
Average price per unit sold ...	4·66d.	**4·64d.**	− ·02d.

The effect of the revenue upon the gross profit is obvious, and one point may be mentioned which indicates that the results are even better than shown in the accounts. The electricity supply department is called upon to light the Free Library free of any charge. This made a difference of £94 in the revenue for the year 1898, and of £104 in the last financial year. The results were as follows:—

	Units sold private.	Public lighting.	Supplied free to Library.	Total output.	Number of public lamps.
1898	140,199	16,197	4,758	161,154	16 arcs and 22 incandescent.
1899 ...	177,165	17,457	5,302	199,924	16 arcs and 22 incandescent.

The average receipts per unit are fairly high, but the business is still small, and it cannot be expected that the expenses would be met with such a low price received as rules with larger undertakings.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£3,125	4·66d.	**£3,863**	4·64d.	− ·02d.
Meter rents, &c.	96	·14d.	**121**	·15d.	+ ·01d.
Sale of lamps and old material	114	·17d.	**103**	·12d.	− ·05d.
Sundry fees, rents received, &c.	14	·02d.	**14**	·01d.	− ·01d.
Gross revenue ...	£3,349	4·99d.	**£4,101**	4·92d.	− ·07d.

The works cost of under 1¾d., and total costs of a little over 2¾d. are good, especially in view of the reductions of over ½d. and ¼d. respectively effected in 1899. It will be seen that the gross total costs only rose £15, although the output increased by 38,770 units. Nearly all the increase in revenue therefore appears as gross profit.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit	Increase.
Coal	£424	·63d.	£496	**·60d.**	—·03d.
Oil, waste, water and engine room stores.	159	·24d.	161	**·19d.**	—·05d.
Salaries and wages incurred in generation and distribution and attending public lamps	470	·70d.	559	**·67d.**	—·03d.
Repairs and maintenance of buildings, engines, boilers, dynamos, and repairs street lamps	460	·68d.	218	**·26d.**	—·42d.
Works costs	£1,513	2·25d.	£1,434	**1·72d.**	—·53d.
Rent, rates and taxes ..	114	·17d.	197	**·24d.**	+·07d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	310	·46d.	336	**·40d.**	—·06d.
General establishment charges, stationery and printing, law charges and insurance.	363	·54d.	378	**·46d.**	—·08d.
Other expenses (deputations, &c.).	40	·06d.	10	**·01d.**	—·05d.
Total costs ...	£2,340	3·48d.	£2,355	**2·83d.**	—·65d.

Under the head of "management" the electric lighting department is called upon to pay a sum every year towards the general expenses, officials' salaries, upkeep of Town Hall, &c., which is out of proportion to the size of the undertaking. Thus in 1898 the charge was £260, and in 1899 £266, while in 1897 it was as much as £306. The financial result last year was a surplus of over £200 after meeting all charges. This may be attributed to good engineering management.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£722	£795
Sinking fund for repayments	765	749
Net profit carried to credit of rates	—478	202
Gross profit	£1,009	£1,746

Stock Exchange Notices.—The Committee has been asked to allow the following to be quoted in the Official List:—British Columbia Electric Railway Company, Limited—Further issue of 1,600 5 per cent. non-cumulative preference shares of £10 each, fully paid, Nos. 37,001 to 38,600. The Stock Exchange Committee has appointed Wednesday, August 29th, special settling days in:—Calcutta Electric Supply Corporation, Limited—Further issue of 10,000 shares of £5 each, 10s. paid, Nos. 20,001 to 30,000, and has ordered the undermentioned to be quoted in the Official List:—National Telephone Company, Limited—Further issue of 100,000 ordinary shares of £5 each, fully paid, Nos. 490,001 to 590,000.

Alliance Electrical Company, Limited.—Warrants for an interim dividend of 5 per cent. on the preference and 10 per cent. on the ordinary shares have been posted.

More Capital.—The Northampton Electric Light and Power Company announce the raising of £5,000 more capital on debenture stock.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending August 18th, 1900, were £1,978 1s. 7d.; receipts for corresponding period, 1899, £1,919 7s. 4d.; aggregate for half-year to date, £9,760 9s. 8d.; aggregate corresponding period of last half-year, £9,900 11s. 4d.

The Bristol Tramways and Carriage Company.—The receipts for the week ending August 17th, 1900, were £3,605 7s. 5d.; corresponding period, 1899, £3,484 14s. 2d.; increase, £120 13s. 3d.

The Central London Railway.—The receipts for the week ending August 18th, 1900, were £4,579; previous week, £5,042; decrease, £463. Total receipts (3 weeks), £13,944. Miles open, 6.

The City and South London Railway Company.—The receipts for the week ending August 19th, 1900, £1,534; August 20th, 1899, £1,080; increase, £454. Total receipts for half-year, 1900, to date, £10,535; corresponding period, 1899, £6,767; increase, £3,768. Miles open, 1900, 4½; 1899, 3½.

The Cork Electric Tramways and Lighting Company.—The receipts for the week ending Thursday, August 16th, 1900, were £576 13s. 5d.; corresponding week last year, £533 16s. 3d.; increase, £43 17s. 2d. Total to August 16th 1900, £13,238 17s. 4d.; corresponding period last year, £11,997 2s. 0d.; increase, £1,241 15s. 4d.

The Dover Corporation Tramways.—The receipts for the week ending August 18th, 1900, were £354 1s. 4½d.; August 19th, 1899, £321 13s. 5d.; increase, £32 7s. 11½d. Total receipts to date, 1900, £6,510 5s. 3d.; corresponding period, 1899, £6,141 4s. 3d.; increase, £369 1s. 0d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,355; 1899, 4,916. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, August 17th, 1900, were as follows:—D. U. T. Co., horse cars, £33 8s. 7d.; ditto, electric cars, £4,320 19s. 0d.; D. S. D. Co., electric cars, £1,361 16s. 4d.; total, £5,716 3s. 11d; corresponding week last year—D. U. T. Co., horse cars, £2,244 19s. 7d.; ditto, electric cars, £1,316 2s. 6d.; D. S. D. Co., electric cars, £1,157 10s. 3d.; total, £4,718 12s. 4d.; increase, £997 11s. 7d.; aggregate to date, £35,061 0s 3d.; aggregate to date last year, £31,889 16s. 8d.; increase to date, £3,171 8s. 7d. The mileage worked is 43 miles electrically, 1 mile by horses, as against 18 miles electrically, 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending August 19th, 1900, were £1,036; corresponding period, 1899, £804; increase, £232. Total receipts to date, 1900, £15,091; corresponding period, 1899, £12,251. Miles of track open, 1900, 14; 1899, 6¾. Number of cars, 1900, 28; 1899, 14.

The Liverpool Overhead Railway Company.—The receipts for the week ending August 19th, 1900, were £1,818; corresponding week last year, £1,695; increase, £123. Total traffics from July 1st, 1900, £12,198; ditto corresponding period, 1899, £11,763; increase, £431. Miles open 6·57 chains.

STOCKS AND SHARES.

Wednesday Evening.

It is being said in the Stock Exchange that business has not been so quiet as it now is since the Baring crisis. For a long time after that catastrophe happened, the stock markets were absolutely apathetic, people not having the money for operations in Capel Court. That condition does not prevail at present. There is plenty of money in the country: were it not so the recent issues of the Electrical Supply companies would certainly not have met with the favourable reception accorded to the majority. The money market is still anxious, certainly, but that is due, not to the want of capital, but to the weak position into which the Bank of England has allowed its resources to sink, a position which is being rapidly remedied. It is from no lack of cash that markets are stagnant. The Chinese and South African situations are both largely responsible for the want of interest in mere Stock Exchange matters which the public now affect, and the holiday season broods over the markets with its usual stifling consequences to business. And so it comes about that only a twenty-fourth part of the securities we quote show any change in price since we last wrote about the market.

Some surprise is expressed in the Telegraph market at the way in which Eastern Telegraph and Eastern Extensions are overlooked as investments. Both are about the same price, having regard to the fact that the Ordinary capital of the first is in stock, and of the second in shares. Both yield about the same rate of interest, Eastern Extensions netting £4 13s. 4d. per cent. to a purchaser; Eastern Ordinary a few pence per cent. more. If anything, it would appear that the latter stock is the cheaper in more ways than that of price. Should the new Pacific cable be laid, the Extension Company is bound to be the heavier sufferer, although now, of course, it is doing an enormous business over the Chinese crisis. But the Eastern Company also benefits by the Oriental trouble, since it carries a large part of its sister company's traffic a good part of the way. Besides this, it has an important string to its bow in the shape of the South African wires. Under these circumstances, it would seem to be a wiser plan to purchase Eastern Ordinary at 148 rather than "China" shares at 15½, equivalent in stock to 15¼.

Indo-European Telegraph shares have declined a pound, which is a small matter, as they stand well over 100 per cent. premium. It is feared that the company will be affected by the terrible famine now raging in the dependency. The Occidental Companies' stocks are retaining their hardness, and Anglo-American Deferred is up ⅛, the dealers being short of stock and anxious to attract a few thousands in the market.

Electric railway and traction shares are quiet, the only noteworthy change being a rise of one point in Waterloo and City stock, an event which has not occurred for weeks past. The stock at its present quotation yields 3¼ per cent. to a buyer, and is being purchased on behalf of those whose existing holding cost them considerably more than the price now current. Beyond these averaging buyers, we do not see that investors have any temptation to take up Waterloo and City when they can get gilt-edged strict-trust stocks to pay them 3½ per cent. and more. Central Londons exhibit no alteration; the market has dropped off in the shares to some extent, and it now remains to be seen whether the virgin traffics can be maintained. Great Northern and City Preferred Ordinary, £7 paid, are quoted at a slight discount. Metropolitan Railway Consolidated stock is weaker at 94, and Districts are down to 27, upon the competition of C.L.R., but London General Omnibus and Road Car descriptions are better, evidently recovering from the first shock of the "Tube's" success.

We now turn to the electricity supply companies, and here the only recordable changes are in Notting Hill Electrics and London Electric Supply Preference. The quotation of the latter has simply been widened, but Notting Hill shares are down 10s., the price being now *ex* the right to the new shares. In these some small market has sprung up, and the price is 1 to 1½ premium.

There is some talk about a huge Melbourne electric company making its appearance in London during the autumn, the concern having acquired certain rights to supply electricity to the town, besides those for constructing over 100 miles of electric tramlines and various other little luxuries. They say in the Australian Stock Exchanges that if a local affair be good, the Colonials are not so foolish as to send it to the Mother Country, *et vice versâ*. Anglo-Argentine Trams are better, shares changing hands over 4, while business has been marked in Buenos Ayres and Belgrano "A" Preference at 5. In the provincial tramway section, Blackpool and Fleetwood shares are 17½ and Glasgow 3½. Potteries Electric Traction have moved up to 12; New General Tractions are 3½.

Telephone shares are steady. National Ordinaries fail to regain the fraction which they lost last week. On the other hand, manufacturing shares are hard at the prices to which they have recently risen. Welsbach descriptions are falling back again, the Ordinary stock being now at 32, and the Deferred can be obtained at 3s. per share.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation August 15th,	Closing Quotation August 22nd.	Business done during week ended August 22nd. 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	58 — 61 xd	58 — 61	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	110½ 111½xd	110½—111½	111½	110⅝
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s.	12 — 12½	12½— 13	12⅝	12½
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	103⅜	102½
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	100 —104%	...	...
60,710£	Direct United States Cable	20	3¼%	3½%	3 %	11 — 11½	11 — 11½	...	...
111,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	145 —150	145 —150	147½	147
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	96 — 99	96 — 99	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	111 —116	111 —116	...	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	14¾— 15¼	14¾— 15¼	15¼	14¾
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	... — ...	... — ...	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	... — ...	... — ...	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	110 —115 xd	110 —115	110	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102 xd	99 —102	99	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5⅛%	5¼%	11 —11½	11 — 11½	11¼	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	14¾— 15¼	14¾— 15¼	15	...
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	31 — 33	31 — 33	...	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —101	98 —101	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	52 — 56	51 — 55	51	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	105 —108	105 —108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅜— 4⅞	4⅜— 4⅞	4 1/16	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	14½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14 xd	12 — 14	13⅜	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	4⅞— 5⅛xd	4⅞— 5⅛	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 —100	97 —100	99	98
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7½— 8½	7½— 8½	8⅛	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4⅜— 5½	4⅜— 5½	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	5 — 5½	5 — 5½	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs....	100	...	...	...	98 —101	98 —101	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	... — ...	... — ...	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14¾—15¼ xd	14¾— 15¼	15 1/16	14⅞
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	¾%	2 %	⅝%	⅝— ⅞	⅝— ⅞	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6½— 7½	6½— 7½	6 1/16	6½
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	6 — 7	6 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref....	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9 — 10	9 — 10	9⅜	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7½	6½— 7½	...	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	4½%	...	...	108 —111	108 —111	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000...	10	10 %	6 %	4 %	7½— 8½	7½— 8½	8½	7⅞
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	12½	12 7/16
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	123 —128	123 —128	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	9	8⅞
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11 — 12	11½— 12½	11 1/16	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	107 —110	107 —110	...	...
26,100	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	4 1/16	4⅛
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	99 —102	99 —102	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1 — 1½	1 — 1½	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4 — 4½	3½— 4½	4½	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —100	98 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	14 — 15	14 — 15	14 1/16	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	111 —114	111 —114	...	...
220,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	96 — 98	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15 — 16	15½— 16½	14½	15½
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15 xd	14 — 15	14⅝	14½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9 xd	8 — 9	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95 xd	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3 — 4	3 — 4	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	12 %	13 %	12 — 13	12 — 13	12½	12⅝

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Aug. 15th.	Closing Quotation Aug. 22nd.	Business done week ended Aug. 22nd, 1900. Highest	Lowest.
		‡							
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2⅞— 3⅛	2⅞— 3⅛	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
30,000	British Electric Traction	10	...	6 %	...	14 — 15	14 — 15	14⅛	14⅜
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12⅜
200,000	Do. do. 5 % Perpetual Debenture Stock	Stock	...	...	...	123 —126	123 —126	123½	122¼
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	¾— ⅞	⅜— ½	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000	...	...	...	...	1⅜— 1⅝	¾— ⅞	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11½— 12½xd	11½— 12½	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,000	5	...	...	...	5⅞— 6¼xd	5⅞— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 %	5 %	...	1⅝— 1⅞	1⅝— 1⅞	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2 — 2¼	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	108 —113	108 —113	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red	Stock	...	...	...	101 —103	101 —103	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000	5	12½%	15 %	15 %	13 — 14	13 — 14	...	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 5⅜	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red	S ock	...	...	...	110 —114	110 —114	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10 7/16	10 1/16
61,033	Do. do. Pref. half-shares	5	...	...	...	5 — 5½	5 — 5½	5¼	5
71,447	Do. do. Def. do.	5	...	...	...	5 — 5½	5 — 5½	5¼	5 3/16
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	55 — 58	55 — 58	57	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	5 — 6	5 — 6	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	7½%	3¾— 4¼	3¾— 4¼xd	4	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1⅜— 2⅛	1⅜— 2¼xd	1⅞	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	6 %	6 %	6 %	3½— 4½	3½— 4½xd	...	...
344,023	Do. do. do. 4 % Deb. Stock Red	100	...	...	...	91 — 93	91 — 93	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅞— 2⅛	1⅞— 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000	2	7 %	7 %	...	2¾— 3¼xd	2¾— 3¼	...	...
140,300	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	13 — 14	13 — 14	13⅝	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5 — 5½	5 — 5½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works	10	10 %	10 %	...	21 — 22	21 — 22	21 1/16	21⅜
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3¼%	3¾%	8 1/16— 9 1/16	8⅞— 9	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13 — 13½	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39xd	35 — 39	37¾	37¼
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909	100	...	...	...	101 —104	101 — 104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10½— 11½	10½— 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000	5	...	...	...	5¼— 5¾	5¼— 5¾	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	89 — 92 xd	90 — 93	92	91

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 102—105.
National Electric Free Wiring, 12/6 paid, 7/- —9/-.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—11.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 7—7½. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17⅜.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, August 22nd.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal)	per ton	£33	£33	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17	£17	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25 10	£25 10	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks	per lb.	3½d.	3½d.	..
a ,, Caustic (75/80%)	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks	per lb.	3¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£80 to 150	£80 to £150	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn)	per lb.	8¼d.	8¼d.	..
c ,, Wire, basis	per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed)	per lb.	11¼d.	11¼d.	..
c ,, ,, (solid drawn)	per lb.	11d.	11d.	..
g Copper Bars (best selected)	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
e ,, (Electrolytic) Bars	per ton	£83 10	£83 10	..
e ,, ,, Sheets	per ton	£92	£92	..
e ,, ,, Rod	per ton	£85 10	£85 10	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	..	..	..
h India-rubber, Para fine	per lb.	3/11½ to 4/2½	3/11½ to 4/2½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants)	per ton	71/9	71/6	3d. inc.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8	per ton	£12 15	£12 15	..
g Lead, English Ingot	per ton	£17 12 6 to £17 17 6	£17 12 6 to £17 17 6	..
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 5	£9 10	5s. dec.
d Mica (in original cases), small	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large	per lb.	3/8 to 7/3	3/8 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 13 6	£3 13 6	..
p Silicon Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£143 to £144	£145 10 to £146	dec.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb b'ndl's	per lb.	8½d.	8½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs.	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs.	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove	per ton	£14	£14	..
k Zinc, Sh't. (Vielle Montague ond.)	per ton	£24 5 nett.	£24 5 nett.	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

AUTOMOBILES AS SOURCE OF REVENUE FOR CENTRAL STATIONS.*

By ELMER A. SPERRY.

(*Concluded from page* 280.)

Again, for instance, where two motors are employed, the power and efficiency is divided, requiring, it is found, a larger amount of power from the battery to drive a vehicle of given weight a mile upon standard road; again, the mechanical condition of the bearings, or amount of rolling friction present in carriages of different makes, also varies. It is evident, therefore, that a number of important considerations should be included in any attempt to give a definite or prescribed mileage capacity to electrical vehicles and their batteries.

In electric road traction the consideration of prime importance is the battery. What is its efficiency, its durability, and, above all, at what cost will it produce a ton-mile?

We will confine our attention in the following remarks to that class of storage battery known as the lead-lead element. These batteries are of two general kinds:—The one having its active material formed or developed from metallic lead—Planté's process, the other having its active material mechanically applied—the Brush or Faure process.

A prominent German writer, giving results of recent tests, states that an average carriage, with a Planté battery, would run 20 miles per charge, the battery weighing 1,260 lbs., yielding 2·8 ampere-hours per pound, 5·25 watt-hours per pound, and requiring 51 lbs. of battery per ton-mile; whereas, with the Faure battery of the same capacity, he found the weight to be 980 lbs., yielding 3·6 ampere-hours per pound, 6·5 watt-hours per pound, running the same carriages an average of 29 miles, requiring 30 lbs. of battery per ton-mile, showing a life of 3,000 and 4,000 ton-miles. This simple report reveals the fact that batteries of different weights, though possessing the same capacity, will propel the same vehicle different distances, requiring a marked difference in the pounds of battery per ton-mile. One of the highest engineering authorities in storage batteries recently stated:—

"The advantage which would follow the introduction of a high capacity cell would not be merely the extension of the radius of action of the electrical vehicle, but would be a lengthening in the life of the battery itself. This is brought about by the fact that it would almost entirely remove the most powerful cause for deterioration—that of over-discharge. Present batteries have 20 to 30 miles' capacity. In the case of a battery capable of propelling a vehicle 60 miles on one charge, only the most inexcusable carelessness could bring it to the state of complete discharge, for 90 per cent. of the discharges would be for distances of less than 30 miles. Under these circumstances, the battery would be seldom discharged over 50 per cent. of its capacity, a condition of affairs which would ensure a greatly increased life, probably between four and six times the life under present conditions."

The importance of proper manipulation, also proper adjustment of the capacities to the work to be performed, is here emphasised. Not only will it be seen that the life of the battery is improved, but, what is more important, the cost per ton-mile is also materially reduced. In this connection, it will be interesting to investigate the relation of the cost of operation per mile due to this factor, namely, the storage battery. Very little, if any, literature is available on this all-important subject, and, in fact, so little experience up to the present time has been available, and so little information has been given out, that it is not surprising that only meagre records of this function exist.

Beginning with the supposition that the present heavy batteries, namely, those yielding about 2½ amperes per pound, are possessed of a given life, certain deductions will be made by introducing series of variables yielding results and data, the bearing and significance of which is of more than passing interest.

Before entering upon a more detailed discussion, it might be well to state the result of more general observations in this line. The desirability of the electrical system of traction, the extent of its adoption, and consequent extent of the demand of the central station for supply, will depend upon the earning capacity that can be demonstrated. The value and present cost of the same work are both known factors. The question remains, what is its cost under the new conditions? Under practical conditions of operation, a battery having a life equal to 1,000 ton-miles will drive a vehicle weighing a ton 1,000 miles, or a vehicle weighing two tons 500 miles. For purposes of illustration of the possible cost of this factor, let us assume that this battery costs $500. It will then be seen that each cab mile covered in the latter instance will cost $1; which would, of course, be prohibitive. Nevertheless, it is a fact that batteries have been made and marketed, and, what is still more serious, others have been so misused in practice, so as to have a life less than above assumed. Suppose the average life of the battery to be five times that assumed, the new cost per cab-mile will be 20 cents.

In the early stages of any industry conditions are often found to exist, the practical results of which, though startlingly disappointing, are finally met and overcome; and especially is this true where the result is an important one, and where capital and skill are available. This is most certainly true of the art under consideration, and within the past year advances have been made that are favourable in the extreme—advances that are destined to reverse the adverse verdict, and to place the art of electric road traction by batteries high above possible criticism.

Taking unity as a basis of the battery factor in the cost per mile, we will proceed to introduce the variables as to weight and cost, and to note the results. Suppose we assume that the heavy battery is about half the total weight carried. Engineer Maxim, in his Milwaukee paper, says 45 per cent. This is close enough to 50 per cent. for present purposes.

First, assuming a battery of same capacity to weigh one-half, it will at once be noted that the vehicles carrying a battery of only one-half the present weight can easily be made one-eighth lighter, giving a total reduction of weight of one-fourth plus one-eighth, or three-eighths. The capacity remaining the same, the lighter combination, or new carriage, will be propelled unity divided by 625, or 1·6 times its former mileage. This factor—1·6—represents the new mileage, yielding the new cost per mile of five-eighths, or ·625. In the above calculation it has been assumed that the lighter battery costs the same as the heavier battery, or twice the cost per pound.

Light battery costing the same per pound as heavy battery, the cost is now reduced to one-half, but the battery is of the same capacity, and will propel the vehicle 1·6 times its former mileage. Introducing this factor, we have a new cost per mile of less than one-third (.31).

Important reductions in cost per pound of battery have been made during the past year. Let us now assume the following:—

Light battery costing one-half per pound of the heavier battery, the cost becomes at once one-half of one-half, or one-fourth; but we must still introduce the mileage factor of 1·6, which yields 1·5, or a cost per mile of one-seventh (.155).

In the above calculations we have assumed only the original life of the batteries, with no renewals. It is found in practice that vehicle batteries with the renewals cost about one-half the first cost of battery, and the life by renewing is extended half the former period; a condition, it will be observed, that does not alter the cost factor per mile.

It has been found that a battery when exhausted weighs as much, and is possessed of its full quota of chemical Pb., and though heretofore it has been difficult to recover any portion of its original cost, at present, with the batteries of one maker at least, it is possible to recover and re-use the exhausted material over and over again, at slight additional cost, the original total investment in lead being practically the only investment required.

Assuming, now, that these renewals be made at half original cost, and that the batteries be carried through only four such renewals, it is found that the whole battery cost and energy produced throughout its extended life is six-tenths of that during the first period, which alone has been considered above. Introducing this factor in the last result, we find a cost per mile of practically one-eleventh (.094).

Advances in the art have, however, gone further than reducing the weight of battery by one-half, and it is now possible to obtain on the market batteries of excellent life that have their original capacity with one-third the weight. With such a battery a vehicle required to carry one-third weight of battery can easily be made one-sixth lighter, making a total reduction of the combined weight of one-third plus one-sixth, or one-half. This battery, having the same capacity, will push the lighter vehicle a distance of unity divided by one-half, or twice the mileage possible with the heavy battery, or at a rate of cost per mile of one-half (.5).

The last result assumes that the light battery (one-third weight) costs the same as the heavy battery.

Light battery costing same per pound as heavy battery, the weight being only one-third, the cost will therefore at once be one-third. But it will still drive the carriage twice the mileage, yielding a total cost per mile of one-sixth (.166).

Light battery costing one-half per pound, there being one-third the weight, the cost will at once be one-sixth; the battery, still having the original capacity, will propel the carriage twice the mileage, as above, and will yield a total cost per mile of one-twelfth (.0833).

Carrying this battery through a course of four renewals under the conditions above stated with reference to renewals, we find that through the extended life of the battery the cost per mile has been (.0833 × .6 = .5) equal to one twentieth (.05).

The realisation of these sweeping reductions in cost is all-important. The results are evidenced as follows:—Vehicles with live load, total weight of 1½ tons, have yielded 1,000 miles per discharge with batteries weighing less than 1,000 lbs. Partial realisation of the desirable features yielding the results above given will work economies that are proportionate. The above calculations are given not only as indicating the high point that has been attained in the development of traction batteries, but also as indicating the line in which future effort should be directed for still further advancement.

As showing the position of this country in this most important work, and especially the recent developments and advances on this side, reference will be made to the competitive tests recently concluded in Berlin, in connection with the International Motor Car Exhibition in that city, which were productive of important and valuable data regarding electric-motor vehicles. Not the least interesting is the average weight of battery to the ton-mile. This figure is named as 28 lbs. per ton-mile, but recalculation shows it to be nearer 30 lbs.

It will be seen in the test recorded from the German authority quoted earlier in the paper, that the values of 30 and 51 lbs. per ton-mile were assigned. Values in this country for vehicles most frequently range between 28 and 50 lbs. As the result of experience, the author would state that this value should be held at or below 10, and vehicles that can easily show this value are in daily commercial service; which makes an extremely favourable showing. So light a battery lends itself readily to the duplication of batteries referred to as creating the necessary diversity factor. The results of the

* Read at the meeting of the National Electric Light Association of Chicago, May 24th, 1900.—*Western Electrician.*

battery tests, so-called, made under the auspices of the Automobile Club of France, recently concluded, indicate that the best results must be expected from batteries in which the active material is retained with, or its retention in place upon the gird is materially aided by, the use of proper envelopes; this being especially true with traction batteries. Furthermore, every means should be employed to shield the battery and to insulate the same thoroughly, not only electrically, but especially against jar and vibration. It has been demonstrated that concussion and molecular vibration are factors tending most seriously to disintegrate the elements. A plan has been devised that seems destined to secure this result; it affords a cushion support for the individual plates by the simple device of rendering the cap of the plate supports within the receptacle elastic and yielding, thus allowing it to perform the function of a cushion.

As a result of the past five years' observation of and close contact with this most engrossing work, the author can assure station managers that the time has arrived when traction batteries, under conditions of vehicular traffic, are making excellent records and showing commercial results that are most satisfactory. At last, this element of greatest mystery and uncertainty, and the one that has beclouded the electric-vehicle world from the first, has cleared from the horizon, leaving only known factors, with which we may deal with certainty.

The success of the electric vehicle being thus assured, a steadily increased demand for current is sure to follow, which will result in large business. This field belongs to the central station by right of discovery; but history repeats itself, and the opportunity will be lost if the territory is not occupied and its resources developed. The central station organisation and equipment is the proper guardian and natural source of expert service and attendance for both battery and machinery, and will be naturally looked to to foster the interests that it shares with the vehicle operators. It has not been demonstrated that central station owners should not be the principal operators themselves. Much can be said in favour of such a combination. In any event, they should closely ally themselves with this important industry, and the earlier a practical experience is had by the station men themselves, the sooner will they understand the needs of the business, and the sooner will they be prepared to guide their patrons into a successful and widespread use of electric road traction.

OPERATING ECONOMIES IN CENTRAL STATION PRACTICE.*

By W. L. ABBOTT.

In every central station there grows up a characteristic system of practices, good, bad or indifferent, due partially to peculiar environments and partially to the ability of the operating force. Through natural selection the best of these practices are gradually crystallised and become the unwritten code of rules for the direction of the internal affairs of the station. Some of these practices, while the very best for that station in which they originate, may prove very unsatisfactory when transplanted into other stations, yet it is largely due to the cordiality with which central station managers impart to and adopt on trial from each other, new methods, that the present rapid improvements in operating details are being made. It is in the hope that some of the methods herein outlined may be new and feasible in other places that these suggestions are offered.

The saving and renovating of waste and oil is an ever-present and variously handled question in all stations. Some simply use the waste until it is oil-soaked and then burn it under the boilers; others go to the other extreme, and use wiping towels, which are carefully saved, washed and used over again. We favour a middle course, using a good quality of waste, first on the finer parts of the machinery and then for coarser work, after which it is put through a washer consisting of a train of rolls over which hot water is running. This extracts nearly all of the oil, and much of the dirt. The oil and water are caught in a receptacle, the oil separated and passed to the oil purifier, and the waste is put into the drier.

This is a sheet-iron box 30 inches square and 6 feet high, filled with shelves one above another made of wire netting and spaced about 10 inches apart, for the reception of waste to be dried. The case stands a few inches from the floor, and in the bottom, which is open, is a steam coil. A door occupies one full side, and to the top is connected an 8-inch galvanised pipe leading to the boiler breeching for the purpose of obtaining a draught. The whole thing is quite simple and inexpensive, yet it will thoroughly dry a charge of 200 lbs. of damp waste in a few hours. This dry waste is somewhat harsh and knotty, but has better absorbing qualities than new waste, and we use and wash it over and over again. In practice the oilers are allowed but ¾ lb. of new waste on a shift, to keep a 1,200-H.P. engine clean, but they are allowed all of the washed waste they want.

In separating oil from waste it is difficult to say which is the by-product and which the direct product, as from 100 lbs. of oily waste we get 40 lbs. each of oil and waste, and one product is about as valuable as the other.

The amount of engine oil used at our Harrison Street station, I think, has been reduced to the lowest possible minimum, as it amounts to only about 50 gallons of new oil each month. This is obtained by catching and re-refining all the lubricating oil used on our machinery, which is quite readily possible on vertical engines. The drains from our crank-pits are carried down into the oil refiners, and the oil from the waste is all saved and put through a purifying process. I have spoken of oil refiners, and of refining the oil, instead of filters and filtering the oil, for the reason that we have no filters and do no filtering, but purify the oil by settling and boiling.

Our filters consist essentially of three tanks, the first of which receives the oil from the engines mixed with cylinder drips, and water from the journals, &c. When this enters the first tank, which is, say, half full of water and half full of oil, the water and oil separate; the water going to the bottom, where it is drawn off through a trap, and the oil going to the top, to be drawn off through an overflow. From the first tank the oil flows to a second tank, in which is a steam coil under a pressure of approximately 100 lbs. This heats the oil up to about 250°, at which temperature the water is driven off in the form of steam. Owing to the surface tension of the oil around the small globules of water which is held in suspension with it, the water will not vaporise at a lower temperature. This tank is of such a capacity that the oil is about two days in passing through it. From the second tank the oil goes into the third tank, where it is allowed to stand about the same length of time, and where any sediment it may contain will be deposited. From the third tank the oil overflows into a large storage tank, where it is kept until it is drawn off to be used.

The question of cylinder lubrication was once a very perplexing one for us, but after studying and experimenting, we settled the question in such a way that it has not been opened for several years. We had great trouble with cylinder oil, and much difficulty in trying to find an oil which would lubricate all of the cylinders of our triple-expansion engines from one lubricator. We have not found such an oil, and do not expect to. We could find an oil which would lubricate the high pressure cylinder, and we could find an oil that would lubricate the low pressure, but we could not find a combination which would lubricate all of the cylinders perfectly. We have, therefore, adopted an oil which will lubricate the high pressure cylinder excellently, the intermediate moderately well, while the low pressure shows only a slight trace of oil. As there is no cutting or scratching in the low pressure while it runs dry, and as the high pressure cylinder makes a prompt and vigorous protest if allowed to run dry for a few moments only, we have adopted the oil which will give the best results in the high and let the low be content with what it gets.

We use a heavily compounded high fire-test oil fed into the steam pipe near the throttle, and find that a gallon of oil so fed will give good lubrication for a 1,200-H.P. engine for 12 hours. I have seen a compound engine of this capacity fed at the rate of nearly a gallon an hour without obtaining satisfactory lubrication; the whole trouble lying in the fact that the oil was not adapted to the particular conditions under which the engine was working, and I think this may account for the unmeasured praise or unstinted abuse which different brands of good oil receive from different engineers; and I think, furthermore, that the difference between a good oil and a poor oil made from high fire-test stock lies almost wholly in the amount and kind of compounding.

In arranging an operating force and the pay roll of the central station, the superintendent should carefully arrange his force so that he would at all times have men enough to take care of the amount of work on hand, and at no time have a surplus of help. Further than this, a considerable saving in money can be made by paying the operatives partially in hopes and promises. By this I mean to have a well-defined and well-known line of promotion, and let each one know his position in that line and know that his chances for promotion depend upon his ability, fidelity, and length of time in service. The most demoralising and disorganising practice that can be introduced into a central station is to put a new man, the relative of some official, or the friend of some politician, into a desirable position over the heads of equally good men who have borne the drudgery and hard work of inferior positions, hoping and expecting that when there was a vacancy in a better position they would have the preference.

In many stations the force is divided into a night gang and a day gang, the day gang going off as the night gang comes on, and *vice versâ*. I do not know that this practice is as general now as it was formerly, but I never thought it was well adapted in central station work. In the first place, the hours are too long, and in the next place it does not give the best distribution of labour. The number of men in the station does not vary according to the load. The practice which we instituted several years ago, of bringing the men on one or more at a time, an hour or so apart, and letting them off in the same way, we find can be made to exactly meet the requirements of an uneven load, and enables us to rotate the different men of the same class through all the different shifts during the course of one or two months, thus making the work and the hours of all exactly alike in the cycle.

At the end of each week the schedule is made up for the week to come, for each of the different classes of operatives interested, and this is posted on Saturday night, so that as the men go off work on Sunday, they can see what shift each will have during the coming week. These schedules are altered from week to week, increased or diminished as regards the number of men, and changed in form to conform to the varying conditions of the load curve. As we are not sure what the load will be from day to day or a week ahead, we are obliged to provide men enough to take care of what we assume will be the reasonable maximum. It is, of course, impossible to meet the requirements exactly without breaking a man in two and using the pieces in non-consecutive times of the day, but with

* Abstract of a paper read before the annual convention of the National Electric Light Association at Chicago.—*American Electrician.*

a little care and study it is possible to arrange the schedule to very nearly meet the exact requirements.

The greatest possibilities for saving or wasting about a steam plant are undoubtedly in the coal pile, but as it is a dirty proposition, and many of its features are not well understood, the subject does not receive the consideration to which it is entitled. The average ambitious engineer will spend much time and care on his engine to be sure that the indicator cards are perfectly symmetrical, that the points of cut-off are equal, the release in time, and that the compression rises to meet the admission in a smooth rounded curve. This is proper and commendable, yet the same time spent in studying the conditions of combustion in his furnace might show him a way to make a saving in fuel fourfold greater than is possible in the final refinements of the indicator cards.

A fireman whose wages amount to, say, 20 cents an hour, will burn during that time fuel costing 10 and 15 times as much as his wages. It would not be possible by any sort of driving to save half

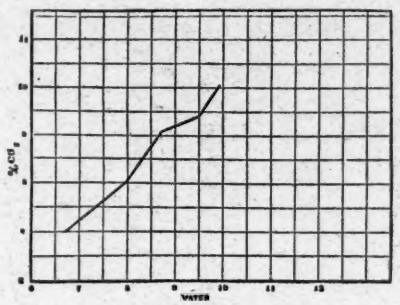


Fig. 1.

of the wages, but it is readily possible, by properly watching and instructing the fireman to save double his wages in coal. In the first place great care should be exercised in the selection of the coal to be used. I believe that the cheapest coal is that kind which has the greatest amount of combustible for the least amount of money, provided the furnaces are of the proper kind and ample in capacity to make the required amount of steam from them. The very cheapest kind of Illinois screenings, costing less than $1.50 per ton, will not have less than 10,000 B.T.U. per pound, and the very best of Eastern lump, costing $4 a ton, will not have more than 14,000 B.T.U. per pound. This means that for equivalent heating qualities, the cheapest screenings cost about half as much as the high-grade coal.

Having selected the coal, the next problem is how to burn it properly. It is commonly understood that 12 lbs. of air are needed to properly burn 1 lb. of coal. It is also commonly supposed that in practice about twice this amount of air passes through the fire, but just how much actually passes, and under what conditions are the best results obtained, it is impossible to determine without making analyses of the flue gases. Fortunately, this has now become a very simple operation, and one which can be performed and understood by any one competent to take charge of a large boiler room.

These tests often show the most surprising and disappointing results. The analyses are made to determine the percentage of carbon dioxide in the flue gases. Under perfect conditions it can run as high as 20 per cent., but it is not unusual to find samples running as low as 2 per cent. of dioxide. This brings down the economy for two reasons. First, the gas in the fire-box is diluted

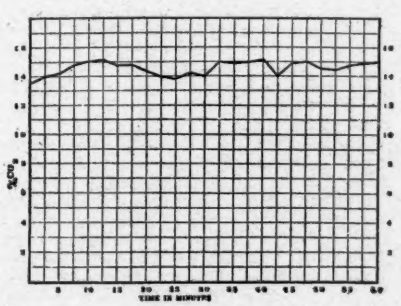


Fig. 2.

with an excess of cold air and cooled down; and, secondly, the volume of gas per pound of weight being increased, it passes through the boiler more rapidly and does not give up so much of its heat. It is almost paradoxical that, within reasonable limits, the more the gases are cooled down in the furnace by the admission of excess of air, the hotter they will pass away from the boiler. The two causes of excess of air in the flue gases are running boilers on too light loads and careless firing.

In a station where the load is much higher for a few hours than during the rest of the day, the tendency is to have too many boilers in service during the period of light load. The natural result is that the fires are run thin, that grates get bare in places, and a great volume of air is drawn in, only a small portion of which comes in contact with the fuel.

An engineer may be aware that he is not getting the results which his tests lead him to believe he should have, and yet, in a boiler room where several men are working, it is exceedingly difficult to fasten the blame on any one of them unless he can examine the chips they make; in other words, the flue gases.

In order to follow intelligently the work of the individual fireman, we have installed in our boiler room a device called the econometer, through which is induced a small current of gas from a boiler breeching. The weight of this gas moves a pointer across a dial, and as the weight changes with the composition, the pointer indicates continuously the varying percentage of carbon dioxide in the flue gas. From this device are run individual pipes to the breeching of each boiler, and all is so arranged that samples may be drawn from several boilers and tested in a few minutes or a continuous test may be made of the performance of any one boiler.

Readings taken from this instrument at regular and short intervals when plotted form a curve which is a very comprehensive record of the conditions of combustion during the time of observation. A few of such curves I submit herewith. Fig. 1 shows the results of a test made to determine the relation between boiler efficiency and percentage of carbon dioxide. The results show that within the limits of the test the two are almost directly proportional. Fig. 2 shows the results of skilful and even firing. Fig. 3 shows what occurs when a fire is cleaned in a leisurely manner; first the dioxide dropped to 1 per cent., then followed a charge of coal which got the furnace in good working condition, but as the fire was not replenished during the next 15 minutes, it burned so thin that it is doubtful if the boiler was making steam at all. The latter part of the curve shows the automatic improvement in the fireman as soon as he observed that he was under surveillance.

Discussion of Mr. Abbott's Paper.

In answer to questions by Mr. Scovil, Mr. Abbott stated that the curves shown were the results of hand firing, and that the com-

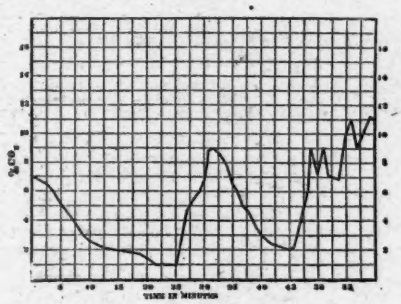


Fig. 3.

pany purposed to instal automatic stokers in the immediate future. Automatic stokers, he said, can be made to show almost any kind of results but do not require nearly so much skill to get good results as is required with hand firing. Mr. Doherty took issue with Mr. Abbott on the statement that coal having the greatest calorific value for a given cost should be used, Mr. Doherty's opinion being that the class of coal which will produce the greatest amount of steam for a given cost should be the basis of selection; many coals which are not high in specific calorific value are much higher in efficiency because they give a higher flame temperature and produce a greater activity in the furnace. In answer to a request from Mr. Cahoon for the details of his method of analysing flue gases with the econometer, Mr. Abbott referred the question to Mr. A. Bement, who explained as follows:—

If the conditions prevailing are those of a thin fire or a strong draught and the indication of carbon dioxide shown by the econometer is low, it is an indication of an excess of air; if, on the other hand, the fire is thick or the draught low, and the indication is low, it is proof of incomplete combustion. The reasons are in the first case the total volume of gases is increased owing to the large amount of air present and which is not used, causing the carbon dioxide to be small in amount in relation to the total volume; second, the carbon dioxide is less with incomplete combustion, because carbon goes to carbon monoxide instead of to carbon dioxide. If the indications of the instrument are irregular it shows an uneven condition which may be, and usually is, accompanied by both an excess of air and incomplete combustion. If the highest carbon dioxide obtainable in a furnace is 15 per cent. and the instrument indicates less than this, it is apparent that something is wrong, and any change in firing conditions is immediately and automatically indicated.

For a chemical analysis we use the absorbing econometer, a modified or improved form of the Orsatt, which I consider has some advantages. I have also used a method by which it was possible to gather a gas sample and make analysis for carbon dioxide and carbon monoxide at two-minute intervals. I found, however, that the method, which is excellent where there is little oxygen present, is not satisfactory when oxygen exceeds about 3 per cent. The absorbing econometer is a very simple instrument; it is used for carbon dioxide determination where the gravity instru-

ment is not available. The gas is pumped into a measuring and absorbing chamber where it is confined and by the movement of a partition the gas is brought in contact with the reagent, the reduction in volume is indicated on a graduated tube by a water column at atmospheric pressure. This is the most rapid of all chemical instruments. I have been able by its use to determine carbon dioxide at one-minute intervals while riding on the front end of a locomotive, and also to make 75 analyses and 75 observations of temperature of escaping gases, and make a record of each, in 75 minutes.

The carbon dioxide determination is so easily and rapidly obtained that it is more useful than more elaborate analysis. We always employ the more elaborate methods of analysis where it appears that such are the best means to obtain the desired information, and these investigations would not be confined to the two carbon oxides and oxygen if there was occasion to go further, but would be extended to hydrogen and hydrocarbon compounds. The only rapid method of determining carbon monoxide that I am aware of is that which I employ. It is very expensive and rather difficult, and the cost of the apparatus was about $200, and while very interesting I consider that it can have no industrial application.

In answer to a question from Mr. White, of Cincinnati, Mr. Abbott stated that the cost of an econometer equipment such as the one used in the Chicago Edison station, for a station of ordinary size, operating two or three boilers, would probably be $175.

SOME DEVELOPMENTS IN THE USE OF PRICE'S GUARD-WIRE IN INSULATION TESTS.*

By Prof. W. E. AYRTON, F.R.S., and T. MATHER.

Everyone who has to test very high resistances, such as those of short lengths of cable and of good joints in insulated wires, cannot fail to appreciate the immense advantage of using Price's "Guard-Wire"† in eliminating errors due to surface leakages. Continued experience confirms the opinion expressed by one of us in the discussion on Mr. Appleyard's paper in 1896; and in our third paper on "Galvanometers," read before the Physical Society in May, 1898,‡ we showed how the principle could be applied to galvanometers, shunt-boxes, &c.

For tests made by the "direct deflexion" method the "guard-wire" properly applied affords complete protection against surface leakage where the ends of the cable tested are near the galvanometer, so that it is possible to have the wire connecting the conductor of the cable with the galvanometer terminal "air-insulated." A difficulty, however, arises when the ends of the cable are at a considerable distance from the testing instrument; this may render "air insulation" of the lead impossible, and so the leakage from the lead must be measured and allowed for. As this "lead leakage" may be as large as or larger than that through the mass of the insulation under test, the convenience and accuracy of the measurement are somewhat impaired. It therefore occurred to us that a guard-wire applied to the lead along its entire length would prove of great value in cases such as the one under consideration. The most effective as well as the simplest way of doing this is to use a concentric wire to connect the cable and galvanometer, the inner of the concentric being used as the "lead," and the outer as the "guard-wire."

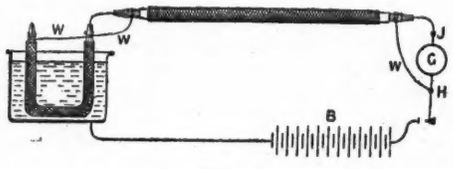


Fig. 1.

The arrangement is shown symbolically in the sketch above. It will be readily understood that so long as the insulation resistance of the outer of the concentric is high compared with the internal resistance of the battery, the method indicated gives complete protection against lead leakage and surface leakage, even if the concentric be laid along the ground for a considerable distance.

Other instances in which special applications of the guard-wire principle have been found convenient have arisen in cases where it has been necessary to determine whether a defective piece of cable was bad throughout, or bad owing to one or more isolated faults. When two tanks are available and one of them can be moderately well insulated from earth, the method of procedure is to coil about half the cable in each tank, remove the metal sheathing (if any) from a short length, say 1 inch, of the cable between the two tanks, and connect the guard-wire with the insulated tank as well as wrap it round the insulating covering near the extremity of the cable, as shown in fig. 2. In the case of braided and other unsheathed cables, the covering of the portion between the two tanks need not be removed. An insulation test applied under the above conditions gives the resistance of the part of the cable in the earthed tank, and a comparison of this with the insulation resistance of the whole will show whether one half is worse than the other half. By repeating this test with say one quarter of the cable in the earthed tank, and the remainder in the other tank, the question of local *v.* general leakage may be decided.

Instead of two tanks, two drums, one of which can be fairly well insulated, might be employed, or one drum and one tank used, for we find that after the braiding of a cable has been thoroughly wetted it acts as a fair conductor for several hours, even on a dry

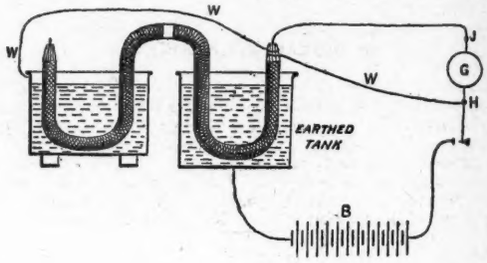


Fig. 2.

day. It is, therefore, not essential to have the part tested completely immersed, although, of course, immersion is conducive to constancy of temperature. Sufficient connection with the wet braiding can be made by wrapping bare wire round it. If the cable be long this may be done at several places along its length.

By employing the two drums above mentioned, faults in braided and other unsheathed cables can be readily localised, without in any way injuring the cable. After connecting the guard wire with the insulated drum, the wetted cable is wound from the earthed drum to the insulated one, the galvanometer being connected with the inner conductor during the process. When the fault passes to the insulated drum a sudden diminution of deflection occurs.

In some cases we have only used one tank (the earthed one in fig. 2) in testing part of a coil of cable, the remainder being first wetted and hung up on a wooden beam supported between two tables. By inserting metal sheets connected with the guard wire between the beam and the tables, errors which might otherwise arise from surface leakage are eliminated.

The guard wire properly applied gives complete protection against surface leakage errors when the tests are made by the "direct deflection" method, but in the "loss of charge" test it is desirable to make measurements both with and without a guard wire. Unless this be done, one cannot be sure that surface leakage is not influencing the results obtained.

A little consideration will show that if any surface leakage exists a guard wire will tend to keep up the potential of the inner conductor during the period of "insulation," and therefore cause the insulation resistance to appear *greater* than its true value; whereas if no guard wire be used, surface leakage will facilitate discharge and cause the insulation resistance to appear *less* than its true value. If, however, the two tests give about the same result (care having been taken to properly discharge the cable between them) we have proof that the effect of surface leakage is inappreciable. It is frequently more expeditious to make the two tests above mentioned than to clean and coat the ends with paraffin wax in such a way as to make one feel confident that no surface leakage exists.

In making the guard wire measurements it is desirable to put the guard as near the braiding or sheathing as practicable, consistent with keeping the resistance between the guard wire and the sheathing high compared with that of the battery. By so doing, any error due to the guard wire is lessened, for the path over which surface leakage can occur is made as long as possible, and nearly equal to that over which leakage takes place when no guard wire is used. An approximate correction is then possible, even when the two tests with and without the guard wire do not give the same result.

Suppose, for example, the swing of the galvanometer needle on the first charge is s_1 divisions, and s_2, s_3 were the swings on "recharge" after the same period of "insulation" with and without guard wire respectively, then the value of the recharge swing, if no surface leakage existed, would be given by the expression

$$s = \frac{s_3}{1 - \frac{s_3 - s_2}{2s_1}} \text{ approximately.}$$

The preceding formula is generally sufficiently accurate for practical purposes, but it is possible to obtain *absolute* accuracy in the use of the guard wire with the "loss of charge" insulation test in the following way:—Instead of maintaining the potential of the guard wire constant, while that of the insulated conductor is steadily falling, cause the potential of the guard wire to fall at the same rate as that of the insulated conductor. Then no electricity can pass between the conductor and the guard wire, and surface leakage will be absolutely prevented.

* Read before the Physical Society, January 26th, 1900.

† Electrical Review, Vol. xxxvii., p. 702 (1895). See also Appleyard on "Dielectrics," *Phil. Mag.* xlii. p. 148 (1896); *Proc. Phys. Soc.* Vol. xiv., pp. 257, 264.

‡ See *Phil. Mag.* October, 1898, p. 368, and *Proc. Phys. Soc.*, Vol. xvi., p. 191.

A potentiometer and an electrostatic voltmeter can be conveniently employed in carrying out this experiment, and it is interesting to remember that the Thomson and Varley potentiometer was originally devised for the special object of enabling the potential of one conductor to be made to diminish as the potential of another conductor steadily fell by leakage. This was not, of course, in connection with the use of Price's ingenious guard wire, but in the days of the old "divided-ring electrometer," before it was known how to make a quadrant electrometer with the deflections *directly* proportional to the P.D. to be observed, and when, therefore, a zero method had to be employed in carrying out the "loss of charge" insulation test.

FAULT TESTS FOR CABLE CORE.*

By ROLLO APPLEYARD.

The following method of localising faults has been found especially useful for braided core, and for core protected by ozokerited-tape. It does not require these coverings to be removed or cut. Fig. 1 shows a convenient arrangement of the test. Drums A and B are supported upon ebonite bearings. The electrical connections are those of the "direct deflection" method, with the addition of a wire, C D, called the "guard wire." The guard-wire terminates at

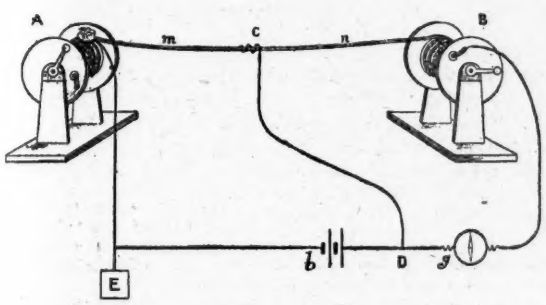


Fig. 1.

C in a rubbing contact piece, which may be a metallic brush or a wet sponge. The ends of the core are brought out through the flanges of the drums. For the sake of clearness, the ends in fig. 1 are shown connected directly to the testing circuit; in practice each end of the conductor should be connected to the iron axle of its corresponding drum. Contact with the testing circuit can then be made through the brass bushing of the ebonite bearing of drum B. A wet cloth attached to an earth-wire, shown on drum A, can be placed either upon A or B. In the case of bare core it is convenient to cover the whole length from A to B with damp cloth.

Faults in core may be (1) single, (2) multiple, or (3) distributed. They may vary in resistance from zero to comparatively high values. It is probable that for each class of fault there is a particular method best suited for determining its position. But, whatever the nature of the fault, the guard wire will be found a most useful aid to localisation.

1. When a single fault of low resistance passes through the contact at C, its presence is indicated by a sudden *fall* in the deflection, for the galvanometer is at that moment automatically short-circuited through the conductor of the cable. Note that the galvanometer is thus completely protected. Simultaneously the battery is connected directly to the fault, and generally burns it out.

2. A fault thus localised should be removed, by cutting it away from the dielectric, and temporarily repaired. The core can then be carried on through C. If there are several faults, the deflection will fall as each in succession passes the guard-wire.

3. In the case of faults distributed along several inches, or even yards, of the core, the bad portion can always be brought to the intermediate stretch from A to B. For this purpose, the earth-cloth should first be laid upon A, and the deflection noted; it should then be removed to B, and the corresponding deflection observed. This determines whether the faulty portion is upon A or upon B, and by winding core from the faulty drum to the good drum, in measured lengths, and by comparing corresponding successive pairs of deflections, the faulty portion passes ultimately from one drum to the other. If the faulty portion is in this way located somewhere along the stretch between C and B, it is clear that by moving the guard wire from C towards B the deflection will gradually diminish, for the current through the galvanometer is thereby more and more shunted. If the fault is uniformly distributed, the fall of deflection is approximately proportional to the distance thus traversed by C. The rate at which it falls as C moves towards B can be compared with the rate of falling when good core is substituted for the faulty portion between C and B.

* Read before the Physical Society, January 20th, 1900.

BLAST FURNACE GAS.

In the mass of evidence, good, bad and indifferent, that was presented to the Committee on the power Bills, there was some by Mr. Harris, who is usually distinguished as Sir F. Bramwell's partner. Mr. Harris had something to say on blast furnace gas, but what he said was far from correct. He did not himself see any advantage in using it in gas engines. Well, that is neither here nor there, and we did only deplore his myopia. But Mr. Harris proceeded to say that the gas was best used under steam boilers, and all the steam produced could be utilised as at present. Now it is well known that the peculiar quality of the poor gases renders them very unsuitable for steam raising. They burn with a transparent flame, carry no solid carbon, and have poor heating effect. Sometimes they are so poor as barely to ignite or burn.

Used to produce power in gas engines, these same gases will produce six times the power that can be got from them as steam producers, and if we assume that at present all the steam they will raise is needed, there remains still five times the power as a saleable surplus.

Our German rivals are making great endeavours and using blast furnace gases for power purposes on a large scale. France also is doing something, so is Belgium, though it makes no acknowledgment of the English origin of the system. A few of our own leading English ironmasters have taken up the question, and it is well recognised that blast furnace gas can be most economically employed. Of course, it cannot be taken direct from the gas main to the engine. It carries too much dust for this to be possible, and no claim is made in this country that some purifying apparatus is not necessary to cool the gas and free it from dust, and it is to be feared that the attempts made by some gas engine makers to force the sale of their engines upon customers with the idea that no cleansing of the gas is necessary will be productive of a set back to the process. It should be clearly understood that blast furnace gas, like all other producer gas, requires to be freed from its contained dust. This done, it will not clog the engine, and will freely ignite in the usual Otto cycle, and it may be calculated upon as possessing about 100 thermal units per cubic foot. The difference necessary in an engine to utilise it is simply the usual alteration in the relative proportions of gas and air inlets, as compared with those of an engine using rich or illuminating gas.

Scientific progress is not so rampant in this country that England can afford to throw away what is estimated on the smaller basis of German iron manufacture to be worth 2½ millions sterling per annum. Yet this possibility is dismissed by Mr. Harris!

THE STATUTORY PROTECTION OF ELECTRICAL SUPPLY COMPANIES.

(BY A LEGAL CORRESPONDENT.)

When an action is brought against an electric supply company for negligence, nuisance, or failure to supply electricity to some consumer within their district, the defence that the company is vested with statutory powers and obligations is often set up. In answer to a charge of negligence, owing to which the plaintiff has suffered injury in personal estate, it is not infrequently urged that inasmuch as the company were acting in pursuance of an Act of Parliament, they are wholly exempt. In answer to a charge of nuisance the same plea is heard, while to the complaint that the company has failed to supply electricity, the company very naturally replies "Certain penalties can be enforced against us, therefore an action does not lie." It is interesting to consider these questions, in order to see how far undertakers are protected by statute.

Primâ facie the electric supply company, in the conduct of its business, is entitled to no further privileges than a private corporation. How far, then, do the Electric Lighting Acts and the various statutes incorporated therewith indemnify them from the consequences which must of necessity flow from the conduct of an industry which cannot fail to be dangerous at certain times in some of its branches? The answer to this question, based upon mature consideration of the Electric Lighting Acts, 1882-1899, and the cases which have been decided thereunder, is that electric lighting companies, in spite of the benefits which they confer upon the community, are in no better position than other companies, the conduct of whose business necessarily involves a certain amount of danger and annoyance to the public.

It might be said with some show of reason that in conferring the right to supply electricity the legislature impliedly

bestowed the right to do every act, whether lawful or not, incident to such supply. A consideration of the Electric Lighting Acts, however, soon dispels this notion.

Thus it is provided by Section 17 of the Electric Lighting Act, 1882, that in the exercise of their powers in relation to the execution of works, either under that Act or any license, order, or special Act, the undertakers shall cause as little detriment and inconvenience and do as little damage as may be, and shall make full compensation for any damage done. The amount of the damage, if not agreed upon, is to be determined by arbitration. With regard to this section, it is important to notice that the compensation referred to is for damage occasioned by the *execution* of the works, and not by their use when constructed [Shelfer *v.* City of London Electric Lighting Company (1895), 1 Ch., 287].

In the case of Hornby *v.* The Liverpool United Gas Light Company [47 J.P. 231], a gas company, for the purpose of their undertaking, broke up the concrete pavement of a street within the limits of their special Act. In the course of such work a servant of the company, in striking the concrete with a pick, caused a piece of the concrete to fly up some distance and break a plate-glass window upon adjoining premises. In an action by the owner of the premises to recover damages, it was decided that the company were liable under Section 6 of the Gas Works Clauses Act of 1847, which was incorporated in their special Act. In the course of his judgment in this case, Carr, J., said :—"The cases have decided that where there is direct damage done to the property of other persons, and the act through which the damage is caused is one which is legalised by statute, the right of action is taken away, and proceedings for compensation are provided instead ; but there is nothing in the Act to show that it was intended that the gas company were to be at liberty to break up the streets, and in the course of doing so to break windows upon either side of the street should that be the necessary consequence of breaking up the streets, and to do so without making any compensation."

As if to make the liability of an electric supply company still more clearly defined, a section was inserted in a later Act of Parliament, which is incorporated with every provisional order. Thus by Section 77 of the Electric Lighting (Clauses) Act, 1899, it is provided that undertakers shall be answerable for all accidents, damages, and injuries happening through the act or default of the undertakers, or of any person in their employment, by reason of, or in consequence of, any of the undertakers' works, and shall save harmless all authorities, bodies, and persons by whom any street is repairable, and all other authorities, companies, and bodies collectively and individually, and their officers and servants, from all damages and costs in respect of those accidents, damages, and injuries. Nor are they protected from liability for the results of nuisances. Thus by Section 81 of the same Act it is provided that nothing in the special order shall exonerate the undertakers from any indictment, action, or other proceedings for nuisance in the event of any nuisance being caused or permitted by them. These sections pre-suppose that damages could have been claimed by the injured party whether the undertakers are acting under statutory powers are no. An injury for which no action could be sustained at common law would not entitle the plaintiff to relief. Thus suppose, in the course of their workings, an electric lighting company were to divert water percolating through the soil, and so deprive the plaintiff of the supply to his well. No damages could be claimed. [Upon this point see New River *v.* Johnson 2 El. & El. 435 ; 29 L.J., M.C. 93 : 6 Jur., N.S. 374 ; 8 W.R. 179.]

The following epitome of certain sections of the Gasworks Clauses Act, 1847 (10 V., c. 15) and the Gasworks Clauses Act, 1871 (34 & 35 Vict., c. 41), which are incorporated with the Electric Lighting Acts, set forth the liability of electric supply companies in connection with the uprooting of streets, &c., and will show how far the common law rights of the public as against a supply company, and of the supply company against the public, are affected by statute. It is provided by Section 6 of the Act of 1847 that undertakers may, under certain circumstances, break up or repair the streets within the limits of their special Act, doing as little damage as may be in the execution of the powers thereby or by the special Act granted, and making compensation for any damage which may be done in the execution of their powers. They cannot, however, lay down pipes or wires in, or enter upon any private land or land not dedicated to public use, without the consent of the owners or occupiers thereof [Section 7]. Moreover, in the case of streets, bridges, or sewers, &c., which the undertakers intend to break up, no step can be taken until notice has been given to the person or persons under whose control the same may be [Section 8], and even then all the works must be conducted under the superintendence of persons having such control [Section 9]. Streets, &c., which are broken up must be reinstated without delay, roads must be fenced and lighted while opened, and must be kept in repair for a certain time after reinstatement [Section 10]. Failure to conform with the provisions of Section 10 involves a risk of incurring penalties [Section 11]; while if the undertakers make default in reinstating streets, the person or persons having control of the same may do the work and recover the cost from the undertakers [Section 12].

Passing from the consideration of the liabilities of undertakers as defendants in such actions, it becomes important to consider their rights of action against persons who in any way interfere with their lines or works. The fact that the offence is one which may be punished by the infliction of penalties at the instance of the undertakers seems to be no bar to an action at law, unless, indeed, the statute expressly takes away the common law right. No such clause can be found in the Electric Lighting Acts.

In this connection reference may be made to Section 20 of the Gasworks Clauses Act, 1847 (10 & 11 Vict., c. 15), which applies to electric supply companies. It is there provided "that every person who shall carelessly or accidentally break, throw down, or damage any pipe, pillar, or lamp belonging to the undertakers, or under their control, shall pay such sum of money by way of satisfaction to the undertakers for the damage done, *not exceeding five pounds*, as any two justices or the sheriff shall think reasonable." This section, which provides for the recovery of a *maximum* penalty of £5, is insufficient to afford adequate protection to an electric lighting or power supply company whose property may be injured to a much greater extent. For instance, damage done to the trolley wire in a street might involve serious loss to a tramway company. For this reason it is important to notice that Section 20 of the Gasworks Clauses Act, 1847, does not oust the jurisdiction of the civil Courts. So in the Crystal Palace District Gas Company *v.* Idris and Co., Limited [64 J. P., 452] which was decided a few weeks ago, a lamp-post, the property of the plaintiffs, was knocked down by the negligent driving of the defendants' servants. The plaintiffs brought an action in the County Court. It appeared that a summons had been taken out under the above section, to which an objection was lodged on the ground that the remedy provided by the Act was one against the person who did the act complained of, and not against his master. The magistrate dismissed the summons, relying on Harding *v.* Barker [53 J.P., 38]. The County Court judge held that his jurisdiction was not ousted, and awarded damages. In this he was upheld by the Queen's Bench Division, Mr. Justice Channell saying :—"Lamps in the public streets are *primâ facie* a nuisance as a hindrance to traffic, but they are authorised by Act of Parliament to be put in the streets, and if one accidently knocks one down, then, of course, the only remedy is under Section 20. But that section contains nothing to oust the ordinary remedy against any person liable at common law for negligently knocking them down, whether the person liable for such negligence be the person who actually knocks down the lamp or not."

HIGHER PRESSURE SUPPLY.

[COMMUNICATED.]

NATURALLY this question has at last come up prominently. Its discussion has, however, been somewhat one-sided. On the one side we find expert electrical engineers, all engaged in, and personally interested in, the distribution and supply of electrical energy at a profit ; on the other we have the consumer who is persuaded that electric light and power are

advantages to him. He, however, is ignorant regarding the factors of electrical energy. The advantages of low pressure or high pressure, and their disadvantages, are not within his ken.

We can all agree with the engineers running municipal electric supply stations, that high pressure has considerable and profitable advantages in distribution; that fact was common knowledge before some of them were born. But most electricians who have had practical experience in advising and acting for *consumers* of electrical energy would agree that there its advantages end.

The only advantage to be expected by the consumer in changing over from low to higher pressure, is that he may thereby get his energy cheaper, the distribution costing less. If, therefore, the supply engineer can save by changing over to higher pressure, the consumer has a right to expect a reduction in the cost per unit of energy delivered. Have such reductions been made?

It is now, however, becoming well known that the increase of pressure increases the cost of electric light and power on the consumer's premises. First, because high pressure lamps are less economical and less durable than low pressure lamps; and a lamp with two filaments costs more to make than a lamp with one filament. Secondly, motors of the small sizes most commonly used on supply systems are more costly and less durable than on low pressures. Thirdly, the whole electric system on his premises, to be paid for and maintained by the consumer, is more expensive on the higher pressure. As a plain matter of fact, the whole of the expense of changing over, both in first cost and maintenance, falls on the consumer, and he is not in a position to know its effects on him for a time.

An intelligent consumer recently asked the question, "What am I to gain by working at 250 volts instead of 110?" The same man wanted to know why some changed over to 200, others to 220, 230, and 250. Not being a consulting electrical engineer to municipalities, it was impossible to explain this puzzle to him.

The first experience the writer had of 250-volt supply was in an installation of 15 motors from ½ H.P. to 7 H.P. In the first month's run 11 motors failed and had to be re-wound, and that after paying an extra price for them on account of the higher pressure. The same firm had run 110-volt motors for eight years without trouble arising, and now their engineer wants to know, "What is the good of 250 volts?"

Let it be clearly understood that the great gain in high pressure is in the distribution only, so that the consumer can only participate in this gain by a reduction in price per unit, such reduction to be sufficient to more than counterbalance the extra cost to him in using the higher pressure.

Of course, at present the consumers' interests need not be much considered. If he does not like high pressure he can leave it; the demand seems to exceed the supply under any circumstances for electric light.

For motors the case is somewhat different; motor users are generally alive to their commercial interests, and if municipal supply does not meet their wants they can generate their own supply at any pressure they please, and under the best conditions for their work.

That higher pressure has come, and come to stay, is undoubted, and lamps, motors and other "translating devices," as our Americans say, shall be made to meet it; but at present, and for some time past, these devices have not exactly "changed over" with perfect success.

Municipal electrical engineering seems to be in a chronic state of "change over" continuous current systems from low to higher pressure, leaving plenty of scope for further "change overs."

Alternating current systems can "change over" from that to continuous, or to polyphase, and then leave many "change overs" possible in frequency and in pressure. And all this necessity for "change overs" exists in plants put up under a few eminent consulting electrical engineers within the last 10 years.

It is to be hoped that the large schemes now before the country for generating and distributing electrical energy on a large scale shall "change over" from these engineers to others who will put down a system which will not require any "change over" within the next 50 years at least. These large schemes are, however, not in the hands of the kind of men who rule the destinies of municipalities, and are, therefore, most likely to have far-seeing skilled electrical engineering talent in their councils.

It is too late now to attempt the most needed of all change-overs in municipal plants, namely, to make them all uniform—continuous supplies, all 250 volts; alternating supplies, all at same frequency, same pressure, and all two-phase.

These big schemes have an immense future before them. If properly set out at the start, they must in time effect a wonderful transformation in manufacturing, and, to a large extent, scatter the over-crowded centres over wider areas. Wherever these generating stations are set up, north, south, east, or west country, they should all be on one plan, uniform, that everything connected with them may be standardised.

With the sad spectacle of the municipal chaos in everything electrical, it will be amazing if the blundering in this respect is repeated.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

14,086. "Improvements in wireless or Hertzian telegraphy." A. C. Brown. Dated August 7th.

14,101. "Improvements in coils or helices for electrical purposes." W. G. Heys. (J. Scott, R. Varley, and J. C. Anderson, United States). Dated August 7th. (Complete.)

14,104. "Improvements in electrodes for the use in electro-chemical processes." O. Lauckner. (A. Vogelsang, Germany.) Dated August 7th. (Complete.)

13,134. "Improvements in or relating to electrical traction." E. J. Pennington. Dated August 7th.

14,139. "Improvements relating to electric railway systems." W. B. Purvis. Dated August 7th. (Complete.)

14,164. "A new or improved insulator." H. Traun. Dated August 7th.

14,170. "A quick make-and-break switch for electrical purposes." H. H. Hill. Dated August 8th.

14,212. "Improvements in or relating to electric furnaces." A. J. Boult. (The Union Carbide Company, United States.) Dated August 8th. (Complete.)

14,215. "Means of fixing electrical appliances to ceilings, walls, furniture, and the like." J. Korner, P. Korner, and E. Mahla. Dated August 8th.

14,237. "A safety device or fender for electric tramways or the like." C. Zimmermann. Dated August 8th.

14,248. "An improved electrical replacement indicator." A. Eckstein and A. E. Mitchell. Dated August 9th.

14,275. "Improvements in and relating to electro-chemical or copying telegraphs." G. C. Dymond. (The Kopier-Telegraph Gesellschaft mit beschrankter Haftung, Germany.) Dated August 9th. (Complete.)

14,281. "Improvements in telegraphy by means of alternating currents and imperfect contacts." G. Ferrie. (Date applied for under Patents, &c., Act, 1883, Sec. 103, January 9th, 1900, being date of application in France.) Dated August 9th. (Complete.)

14,288. "Improvements in electro-magnetic apparatus for jacquards." J. Szczepanik and L. Kleinberg. Dated August 9th.

14,289. "Improvements in electric switches." A. W. B. Pearson. Dated August 9th. (Complete.)

14,324. "Improvement in arc lamps." F. W. Smith, A. J. Smith, and W. J. L. Sandy. Dated August 10th.

14,337. "An electric releasing apparatus for pneumatic pressure brakes." A. Bruggermann and Deutsche Waffen und Munitions Fabriken. Dated August 10th.

14,354. "Improvement in magnetic separating apparatus." The Edison Ore Milling Syndicate, Limited. (T. A. Edison, United States). Dated August 10th.

14,355. "Improvement in magnetic separating apparatus." The Edison Ore Milling Syndicate, Limited. (T. A. Edison, United States.) Dated August 10th.

14,367. "Improvements in electrical contact apparatus." K. de Kando. Dated August 10th. (Complete.)

14,368. "Improvements in liquid rheostats operated by means of compressed air." C. de Kando. Dated August 10th. (Complete.)

14,373. "Improvements in and connected with electrical fuseboards." H. O. Farrell. Dated August 11th.

14,384. "Improvements relating to rail points and overhead switches in electric tramways." W. Carter and J. Bowrey. Dated August 11th.

14,409. "Improvements in electric meters." J. Harris. Dated August 11th. (Complete.)

14,420. "Improvements in combined electric meters and demand indicators." J. G. Lorrain. (A. Wright, at present on the high seas.) Dated August 11th.

14,422. "Improvements in switches and apparatus for use in starting and controlling electric motors." A. H. Adams. Dated August 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

20,008. "Improvements in the manufacture of metallic covers for electrical switches, cut-outs, and the like." M. Lawton (trading as J. Lawton & Sons). Dated September 21st, 1898. Relates to the manufacture of metallic covers for switches, &c. The covers are made from thinned metal blanks, parts of which are left thick for receiving a screw thread, &c. The blanks are stamped, pressed or rolled out of a thick plate, and the rolls, &c., are so formed that the centres or edges of the plate are left sufficiently thick. The blank is then cupped or dished to the required shape. 2 claims.

24,116. "An improved electricity meter." C. Schmidlin. Dated November 15th, 1898. Relates to energy meters. A clockwork drives a counter and rotates a conductive disc, its speed being made proportionate to the power passing by breaking the disc by a magnet carried by the movable coil of an electro-dynamometer. The magnet moves from the edge towards the centre of the disc as the power increases. A lever is weighted to bear on the disc and stop it, when not held away by the main current passing in an electro-magnet. The clockwork may be wound electrically, and any suitable governor is used to limit its maximum speed. Quantity meters are constructed similarly, except that the electro-dynamometer and magnet are dispensed with, and the disc rotates within two stationary coils, one of which carries a constant shunt current to produce the maximum retardation, while the other carries the current to be measured in a direction to reduce the effect of the shunt current. 2 claims.

24,133. "A new or improved open or enclosed arc electric lamp." H. Hirst and H. Bevis. Dated November 16th, 1898. Relates to arc lamps. An open or enclosed arc is struck and regulated by the varying length of a hot metal strip or wire laid round porcelain pulleys on two stationary supporting rods, and electrically connected in series with the carbons. One end of the strip is supported adjustably by a slide and a nut on a fixed screw. The other end is attached to a stirrup and a spring by which the strip is kept extended. The stirrup bears on a knife-edge on a lever which is supported by two lateral knife-edges on stationary bearings; the long arm of the lever is linked to an ordinary clutch in engagement with the upper carbon. Extension of the strip by heating thus allows the spring to turn the lever so that the clutch engages and lifts the carbon. This carbon is placed in a holder which slides in a slotted tube under pressure of a light helical spring. 4 claims.

24,164. "An improvement in electric incandescent lamp shade holders and the like and a device for use in connection therewith." W. H. Bradley. Dated November 16th, 1898. Relates to holders for incandescent lamps. A nut for securing a shade or the like against a shoulder on a lampholder is provided with two opposite slots to receive the ends of special tool for applying the nut to the holder within the shade. The tool consists of a handle carrying a fork and a spring plate, the ends of which stand a little distant from those of the fork, to grip the insides of the slots in the nut when inserted therein. A separate spring plate may be used on each arm of the fork. 4 claims.

24,172. "Process for obtaining a permanent electrical contact at the covers of voltaic cells." H. Schloss. Dated November 16th, 1898. Relates to connections. In cells having air-tight covers carrying terminals with which the plates are connected, the contact surfaces of both the terminals and the plates are amalgamated with a mercury solution to ensure good connection. 1 claim.

24,190. "An improved magnetic circuit-breaker." H. H. Lake. (W. M. Scott.) Dated November 16th, 1898. Relates to underload magnetic circuit-breakers, and to supplemental contacts for taking the spark. The main contact bar is carried by a rod sliding in sockets. To the rod is pivoted the lever carrying the armature of the electro-magnet and the resetting handle. A projection on the lever carries a friction wheel engaging a fixed guide plate, so that when the armature is held up by the magnet, the contact bar is held against the contacts. A spring forces the rod back when the armature falls away. To the rod is also pivoted a lever carrying the supplemental contact arm which engages with the contacts in shunt with the main contacts. A spring gives a quick break, the positive movement being secured by pins. 6 claims.

24,196. "Electrically heating plates, dishes, and the like." C. H. Kahre. Dated November 10th, 1898. Relates to apparatus for heating plates, dishes, &c., while on a dining table. A vessel constructed to receive an ordinary plate or dish, &c., is fitted with an electric resistance coil, through which a current is passed when required. The coil is covered by a perforated plate. The apparatus is fitted with connecting wires and a switch, or a single switch may be used for a set of warmers. 1 claim.

24,264. "An improved switch for incandescence or glow electric lamps in which the filament is subjected to a preliminary heating effect apart from the lighting current." H. Hirst. Dated November 17th, 1898. Switches for incandescent lamps having a filament and a heating appliance. The apparatus is described with reference to a diagram, and is too complicated for description without reference thereto. 3 claims.

24,265. "Improvements in forming filaments or the like for incandescent or glow electric lamps." H. Hirst. Dated November 17th, 1898. Relates to incandescent lamps. Filaments which are conductive when hot are made from organic material dipped in a saturated solution of a refractory earth, or in a creamy mixture of a powdered insoluble salt or oxide with water and a binding material, dried and heated gradually to a high temperature, these operations being repeated until the resulting filament is sufficiently dense. The organic material may be cotton, thread, hore-hair, celluloid, or any suitable twisted, plaited, or woven vegetable or animal fibre. The solution preferably contains six parts of zirconium nitrate to one part of yttrium nitrate; magnesia and thoria are also mentioned. The dipped threads may be submitted to ammonia to produce hydrated oxides. The threads may be cut in lengths and secured in loops on mounted platinum wires before dipping, by which the joints are also coated, or the threads may be treated in long lengths. 4 claims.

24,307. "A process for the electrolytic extraction of zinc and other metals from ores or waste containing them." J. C. Feil. (W. Strzoda.) Dated November 17th, 1898. Pulverised zinc ores, or waste containing zinc, such as zinc-ash, are placed in an electrolytic tank, the electrolyte employed being a caustic solution, such as a 10 per cent. solution of caustic soda. Cathodes of zinc or iron are used, some of which may be loose and arranged to lie upon a wooden lining horizontally at the bottom of the vat. The anodes are of carbon or metal, and are arranged vertically at small intervals apart. The zinc and other metals present, such as cadmium, lead, copper, silver, gold, &c., are first dissolved by the caustic solution, and then immediately deposited by the current in the cathode. The liberated gas causes a constant agitation of the liquid during the process. After the removal of the electrodes, the mass left is filtered, and the zinc finally separated from the other metals by distillation. 1 claim.

24,308. "Improvements in electric batteries." H. J. Haddon. (Columbus Electricitats Gesellschaft, m, b, H.) Dated November 17th, 1898. Relates to a sealed battery in which the electrolyte may be thickened in consistency, and consists in interposing in between the electrodes and the main cover an oil-soaked blanket so that an air space is left between it and the electrodes. The cover has a gas exit in it. 1 claim.

24,371. "Improvements in the regulation of alternating current electric motors, applicable also to distribution systems." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.) Dated November 18th, 1898. Relates to a method of regulating the magnitude or phase of the currents in a multiphase system by inserting or withdrawing resistances or other devices in the various branches or circuits successively rather than simultaneously. The invention is specially applicable to the regulation of induction motors. A diagram is used for reference, and is too complicated for description. 7 claims.

24,379. "Improvements in telephonic apparatus." F. L. Muirhead. Dated November 18th, 1898. Relates to an arrangement of telephonic apparatus on board ship and in other places. A bracket on the front of a junction box carries a transverse tube leading to the receivers. The transmitter is attached to the tube so as to rotate with it. Circuit contacts are also controlled by the tube. The ear-piece tubes are arranged, one fixed and one hinged, so as to allow the ear-pieces to grip over the ears when the apparatus is raised to its operating position. 3 claims.

24,404. "Improvements in insulating and supporting electric conductors." L. Hackethal. Dated November 18th, 1898. Conductors are insulated with a woven fibrous coating impregnated and coated with a mixture of red lead or litharge and linseed oil. The two wires of an overhead metallic circuit are attached to one insulator and are arranged to cross. 2 claims.

24,418. "Improvements in alternating current motors." W. Langdon-Davies. Dated November 18th, 1898. In order to obtain a great starting torque, the field magnets are constructed in the form of a drum-wound slotted continuous ring, with no projecting pole-pieces, and their windings are so distributed as to make the magnetic density strongest at the centre of each pole face, instead of uniform as described in Specification No. 18,870, A.D. 1895. The armature is provided with a continuous winding, coupled at intervals to commutator bars having brushes arranged on a line inclined to the magnetic axis of the field magnets. current may be supplied to the field windings, in which case the brushes are short-circuited, or it may be supplied o the armature windings, in which case the field-windings are short-circuited. Instead of providing each field magnet pole with a sectional winding, a similar effect may be obtained by means of a single coil embracing the central portion only of each pole. For reversing the motor, the field magnet ring may be wound with two sets of coils, arranged at a suitable angle to each other and connected to a switch for bringing one or the other into action as required. 4 claims.

24,438. "Improvement in or in connection with the construction of dry voltaic cells, accumulators, and secondary batteries." C. M. Stead. Dated November 19th, 1898. Relates to dry batteries and consists in the use of peat moss, preferably ground to a very fine powder or flour, as an absorbent for the electrolyte. In the case of primary batteries, the moss may be mixed with plaster of Paris and whiting. 4 claims.

24,466. "Improvements in connection with electric arc lamps." W. N. Stewart and H. H. Wells. Dated November 19th, 1898. Globes for enclosing the arcs of electric lamps are made in parts to facilitate moulding and cleaning, their necks being formed to fit the carbons or carbon holders. The globe may be made in halves separating lengthwise or transversely, one half fitting into the other. The lengthwise globe is held closed by rings on the ends. The two parts of the transverse globe may be made unequal; one part may be merely a cover for the main portion. In another modification, two such covers fit into the ends of a cylindrical part. 2 claims.

24,487. "Improvements in or relating to collectors for electric street railways with overhead conductors." C. Steiner. Dated November 19th, 1898. Collectors for use with overhead conductors. The wheel is mounted loosely on the head which is curved with a radius equal to the length of the pole. 2 claims.

24,532. "Electric cables for high tension currents." B. J. B. Mills. (La Societe Francaise des Cables Electriques Systeme Berthoud, Borel et Cie.) Dated November 21st, 1898. Cables for high tension currents are built up of a central stranded core of bare wires surrounded by a layer of insulated conductors. Several such single cables may be combined with insulating material to form a multiple coil. 2 claims.

24,533. "Improvements in or relating to converting electrical energy into mechanical motion." W. P. Thompson. (C. S. Bradley.) Dated November 21st, 1898. Relates to a method of utilising single-phase currents for operating electric motors, particularly railway vehicle motors. One element of the motor is supplied through brushes with single-phase currents, derived from the trolley conductors, while the other is supplied with polyphase currents, obtained from the single-phase currents of the mains by means of a phase transformer. The rate of alternation of the polyphase currents is varied by means of a motor generator. Condensers are inserted between the motor-generator and the motor for the purpose of varying the speed of the motor. The load of the motor-generator and consequently the rate of alternation of the currents may be simultaneously varied by mounting on its armature shaft a conducting disc which moves in the field of a magnet, the excitation of which is controlled by a variable resistance. The invention is also applicable to stationary motors, fixed connections with the mains being then employed. 7 claims.

24,550. "An electro-therapeutical and massage apparatus." O. Schneider. Dated November 21st, 1898. A massage roller for treating local diseases and constructed to apply electricity or medicinal preparations is made of any suitable cross-section, hollow, and of wooden strips with intermediate metallic strips alternately connected to metallic end pieces. The axle is provided with insulating rollers, &c. A contact pin with spring and a contact spring connect the end pieces to wires extending through the handle and thence to a suitable source of electricity. The interior of the joller may be charged with cod liver oil, or other emulsions, &c., by removing the plug. The liquid is ejected through valves consisting of a projecting tubular nipple with openings at its lower end supported in an open metal socket with a spring between its inner end and the bottom of the socket. To prevent conduction of electricity by the liquid the metal strips extend only partially through the roller, the interior of which is coated with shellac, &c. The roller is connected by a flexible shaft to a fly-wheel driven by a regulated electromotor. To connect the flexible shaft to the roller its square end is inserted in the end of the axle and the thumbscrew is tightened to connect the sleeve of the frame with the coupling piece of the shaft tube. Similarly the other end of the shaft is held by a screw in the hub of the wheel, and the coupling piece by a screw in a sleeve of the supporting bracket. 3 claims.

24,559. "Improvements in electrically propelled road vehicles." H. G. Morris. and P. G. Salom. Dated November 21st, 1898. Relates to electrically propelled road vehicles having the motors carried by the front axle directly under the passenger seat, and the batteries carried by a rear extension supported by the rear axle, the operator's seat being mounted above this rear extension, as in the ordinary hansom cab. The motors are carried on the front axle, and the motor shaft pinions gear with the toothed wheels of the front wheels. Each motor axle, carries a brake disc, so that the brake is applied to the motor direct by means of the chains and levers acting on the shoes when the foot-plate is worked by the operator. The vehicle is steered by turning the rear wheels. Swivel blocks are pivoted to the brackets on the rear axle, and have journals extending into the hubs of the wheels. Through the medium of levers and rods the operator can manipulate the blocks by the hand lever, and so steer the carriage. The box-shaped extension carries the batteries, and is closed at the rear end by the tailboard. The speed controller is mounted directly under the operator's seat, and is operated by the lever. 7 claims.

24,570. "Improvements connected with electric batteries." W. L. Rawson. Dated November 22nd. Relates to batteries of that class in which electricity is generated by the oxidising action of a fused salt upon a molten metal or alloy separated from it by a porous pot or diaphragm, the oxidised metal being reduced by carbonaceous gases and the salt being recuperated by oxygen or air which is forced into it. The invention is described as applied to a battery in which the outer and porous cells are both made of magnesia, and the molten metal is lead, in which is immersed a cast-iron plate serving as an electrode. The other electrode may be the inlet pipe for air to the fuse salt; the pipe preferably extends horizontally along the porous pot, and is perforated to sub-divide the air streams. The invention consists, firstly, in maintaining the necessary heat in the battery by supplying to it a combustible gas such as water or producer gas, coal gas, petroleum, &c., and a supply of oxygen sufficient to combine with the combustible materal, but not to oxidise the molten metal. The invention also consists in causing the pumps supplying the conbustible gas, and the air to be driven by an electric motor operated by the current of the cell, so that the speed of the pumps may vary directly with the output of the cell. When water gas is used as the combustible gas, the products of combustion, consisting of carbonic acid, steam, and nitrogen, may be used to heat the incoming air, but are preferably led back to the gas producer, and used as the raw material for the production of the gas instead of the steam which is generally employed. 2 claims.

24,626. "Improvements in and relating to microphones." E. Hardy and R. Picard. Dated November 22nd, 1898. In microphones, whether used as telephones or as telegraph receivers for sounds produced to represent any code when vessels are in distress, &c., the microphone circuit is employed to act on a recorder magnet so as to produce a trace. The microphones are also described as being fitted in two or more positions on board a vessel so as to locate the position of any sound. The signals may be received in this case by telephones or as telegraphic records. The microphone is arranged with a diaphragm mounted in a ring and having an insulated carbon or other disc secured at its centre. Four or more balanced pivoted arms carry carbon or other pencils to make contact with the disc. The arms have adjustable balance weights or springs. The arms are pivoted in insulated blocks and have one of the pin bearings in each case provided with mercury to ensure good electric contact. 10 claims.

24,641. "Improvements in secondary batteries." N. H. Edgerton and A. K. Masters. Dated November 22nd, 1898. The battery is made up of several superposed trays, each composed of two layers of dissimilar metals, one of which may be of zinc, while the other may be lead. On the lead plate is placed a layer of red lead, over which is laid a layer of powdered or granulated charcoal, in which rests the tray next highest in the series, and the vacant space above the charcoal may be filled with any insulating cement or liquid to prevent the evaporation of the electrolyte. The plates are held in place in a casing by means of a screw bearing on a wooden cross piece. 6 claims.